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(54) **METHOD OF PRODUCING L-AMINO ACID**

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None  
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(57) **ABSTRACT**

An L-amino acid is produced by culturing a microorganism belonging to the family Enterobacteriaceae having an L-amino acid-producing ability and modified so that glycerol dehydrogenase and dihydroxyacetone kinase activities are increased, in a medium containing glycerol as a carbon source to produce and accumulate an L-amino acid in the medium or cells, and collecting the L-amino acid from the medium or the cells.

**13 Claims, No Drawings**



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**METHOD OF PRODUCING L-AMINO ACID**

This application is a continuation under 35 U.S.C. §120 of PCT Patent Application No. PCT/JP2008/053020, filed Feb. 22, 2008, which claims priority under 35 U.S.C. §119 to Japanese Patent Application No. 2007-041724, filed on Feb. 22, 2007, which are incorporated in their entireties by reference. The Sequence Listing in electronic format filed herewith is also hereby incorporated by reference in its entirety (File Name: US-405\_Seq\_List; File Size: 438 KB; Date Created: Aug. 24, 2009).

**BACKGROUND OF THE INVENTION****1. Field of the Invention**

The present invention is related to the field of fermentation, and more specifically to the production of L-amino acids via the fermentation of microorganisms.

**2. Brief Description of the Related Art**

L-Amino acids are industrially produced by fermentation using microorganisms belonging to the genus *Brevibacterium*, *Corynebacterium*, *Escherichia*, or the like. In such production methods, strains are used which are isolated from nature, or artificial variants of such strains. Furthermore, microorganism strains can be used which are modified by a recombinant DNA technique to increase activity of a basic L-amino acid biosynthesis enzyme, and so forth (EP 0643135 B, EP 0733712 B, EP 1477565 A, EP 0796912 A, EP 0837134 A, WO 01/53459, EP 1170376 A, WO 2005/010175, and WO 96/17930).

When amino acids are produced using microorganisms, sugars are generally used as a main component of substrate, but glycerol can also be used as a substrate (EP 1715055 A and EP 1715056 A).

It is known that *Escherichia coli* has a plurality of genes which participate in glycerol metabolism. However, it has been revealed that, since a mutant strain deficient in *glpK*, which is a gene coding for glycerol kinase, or *glpD*, which is a gene coding for glycerol-3-phosphate dehydrogenase, cannot grow in a medium when glycerol is the sole carbon source, the major glycerol assimilation pathway of *E. coli* consists of glycerol kinase and glycerol-3-phosphate dehydrogenase (J. Bacteriol., 23 (2006) 8259-8271).

It is known that glycerol dehydrogenase of *E. coli* is also one of the enzymes which participate in glycerol metabolism, and it recovers a mutant strain deficient in the three genes of *glpK*, *glpD* and *glpR*, which is a gene of repressor of the *glp* regulon, from lethality thereof in a medium containing glycerol as a sole carbon source in screening using that strain (J. Bacteriol., 131 (1977) 1026-1028).

The pathway via glycerol-3-phosphate including glycerol kinase and glycerol-3-phosphate dehydrogenase is thought to be the main glycerol assimilation pathway of microorganisms belonging to the family Enterobacteriaceae as described above, and the glycerol assimilation pathway via dihydroxyacetone is an unnecessary pathway for glycerol assimilation of microorganisms belonging to the family Enterobacteriaceae.

**SUMMARY OF THE INVENTION**

An aspect of the present invention is to provide a method for producing an L-amino acid by fermentation using a substrate containing glycerol, which is improved compared with conventional techniques.

It has been found that enhancing either glycerol dehydrogenase or dihydroxyacetone kinase, which are enzymes of the

glycerol assimilation pathway via dihydroxyacetone, was not effective for production of L-amino acids from glycerol. However, enhancing both glycerol dehydrogenase and dihydroxyacetone kinase markedly improved the production of L-amino acids from glycerol.

It is an aspect of the present invention to provide a method for producing an L-amino acid by (A) modifying a microorganism belonging to the family Enterobacteriaceae having an L-amino acid-producing ability to increase glycerol dehydrogenase and dihydroxyacetone kinase activities, (B) culturing said microorganism in a medium containing glycerol as a carbon source to produce and accumulate an L-amino acid in the medium or cells, and (C) collecting the L-amino acid from the medium or the cells.

It is a further aspect of the present invention to provide the method as described above, wherein the glycerol dehydrogenase and dihydroxyacetone kinase activities are increased by increasing copy numbers of genes coding for glycerol dehydrogenase and dihydroxyacetone kinase, or modifying expression control sequences of the genes.

It is a further aspect of the present invention to provide the method as described above, wherein the dihydroxyacetone kinase uses ATP as a phosphate donor.

It is a further aspect of the present invention to provide the method as described above, wherein the microorganism is further modified to increase glycerol uptake activity.

It is a further aspect of the present invention to provide the method as described above, wherein the microorganism is further modified to increase the activity or activities of an enzyme selected from the group consisting of triosephosphate isomerase, fructose biphosphate aldolase, fructose-1,6-bisphosphatase, fructose-6-phosphate aldolase, and combinations thereof.

It is a further aspect of the present invention to provide the method as described above, wherein the microorganism is further modified to reduce the activity or activities of glycerol kinase and/or membrane-binding type glycerol-3-phosphate dehydrogenase.

It is a further aspect of the present invention to provide the method as described above, wherein the microorganism belonging to the family Enterobacteriaceae is an *Escherichia* bacterium, or a *Pantoea* bacterium.

It is a further aspect of the present invention to provide the method as described above, wherein the L-amino acid is selected from the group consisting of L-glutamic acid, L-lysine, L-leucine, L-isoleucine, L-valine, L-tryptophan, L-phenylalanine, L-tyrosine, L-threonine, L-methionine, L-cysteine, L-arginine, L-serine, L-proline, L-asparatic acid, L-asparagine, L-glutamine, and L-histidine.

**DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS**

Hereafter, the present invention will be explained in detail.

**<1> Microorganism**

Exemplary microorganisms of the present invention include a microorganism belonging to the family Enterobacteriaceae, which has an ability to produce an L-amino acid and is modified to increase glycerol dehydrogenase and dihydroxyacetone kinase activities. The ability to produce an L-amino acid (L-amino acid-producing ability) can mean an ability of exemplary microorganisms of the present invention to produce and accumulate an L-amino acid in a medium or cells when cultured in the medium. An exemplary microorganism of the present invention may have an ability to produce two or more kinds of L-amino acids. Although the microorganism having L-amino acid-producing ability may

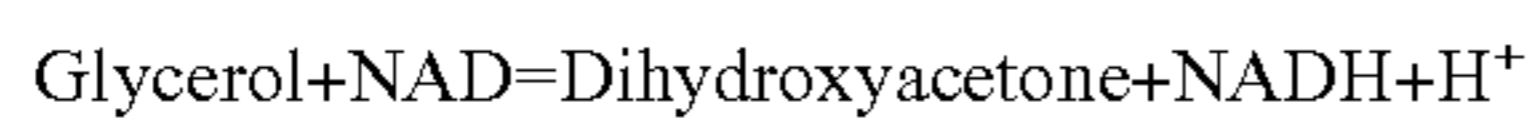


inherently have L-amino acid-producing ability, the microorganism can also be obtained by modifying such microorganisms as mentioned below using a recombinant DNA technique so that they have L-amino acid-producing ability.

Although the type of L-amino acid is not particularly limited, examples include basic amino acids such as L-lysine, L-ornithine, L-arginine, L-histidine and L-citrulline, aliphatic amino acids such as L-isoleucine, L-alanine, L-valine, L-leucine and L-glycine, amino acids which are hydroxymonoaminocarboxylic acids such as L-threonine and L-serine, cyclic amino acids such as L-proline, aromatic amino acids such as L-phenylalanine, L-tyrosine and L-tryptophan, sulfur-containing amino acids such as L-cysteine, L-cystine and L-methionine, acidic amino acids such as L-glutamic acid and L-aspartic acid, and amino acids with amide group at the side chain such as L-glutamine and L-asparagine. An exemplary microorganism of the present invention may have an ability to produce two or more kinds of L-amino acids.

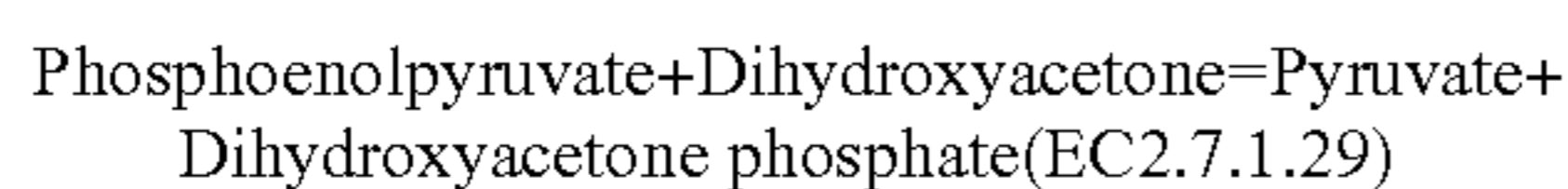
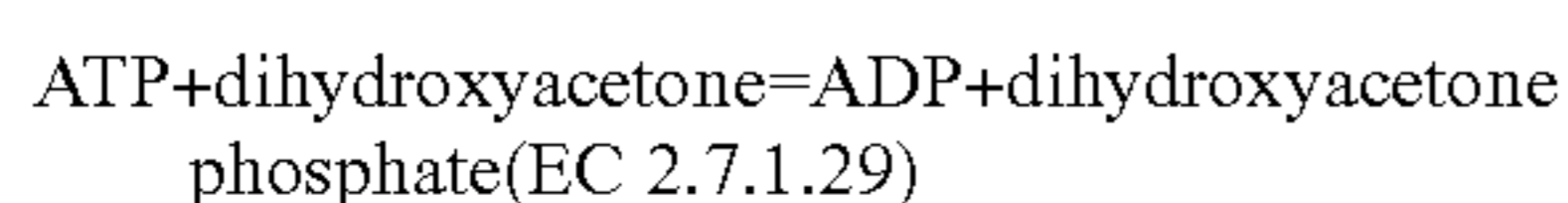
Microorganisms belonging to the family Enterobacteriaceae include *Escherichia bacteria* and *Pantoea bacteria*. Other examples of microorganisms belonging to the family Enterobacteriaceae include microorganisms belonging to  $\gamma$ -proteobacteria such as those of the genus *Enterobacter*, *Klebsiella*, *Serratia*, *Erwinia*, *Salmonella*, *Morganella* or the like.

“Glycerol dehydrogenase” can mean an enzyme which reversibly catalyzes the following oxidation reaction that converts glycerol into dihydroxyacetone by using NAD as a coenzyme (EC: 1.1.1.6).



The phrase “to increase the glycerol dehydrogenase activity” can mean that the number of the glycerol dehydrogenase molecules per cell can be increased compared with that of a wild-type strain or non-modified strain, or that the activity of the glycerol dehydrogenase per molecule can be improved compared with that of a wild-type strain or non-modified strain. Moreover, when the enzyme activity is undetectable in a wild-type strain, and it is improved to a detectable level, this can also be included in the state of “the activity increases”. The glycerol dehydrogenase activity can be at any level so long as it can be detected, but the modification is preferably performed so that the glycerol dehydrogenase activity is 0.05 U/mg or higher, in another example 0.25 U/mg or higher, and in another example 0.5 U/mg or higher. Examples of wild-type strains of the microorganism belonging to the family Enterobacteriaceae which can serve as a reference for comparison include the *Escherichia coli* MG1655 strain (ATCC No. 47076) and W3110 strain (ATCC No. 27325), *Pantoea ananatis* AJ13335 strain (FERM BP-6615), and so forth. The glycerol dehydrogenase activity can be measured by referring to the method of Ansis, R. E. et al. (J. Biol. Chem., 2-3, 153-159 (1953))

“Dihydroxyacetone kinase” is an enzyme which reversibly catalyzes the following reaction that converts dihydroxyacetone into dihydroxyacetone phosphate, and one uses ATP as a phosphate donor (EC 2.7.1.29), and one uses PEP as a phosphate donor (EC 2.7.1.29) (Cell. Mol. Life. Sci., 63 (2006) 890-900; Biochemistry, 43 (2004) 13037-13045)



In one example, dihydroxyacetone kinase can use ATP as a phosphate donor.

The phrase “to increase the dihydroxyacetone kinase activity” can mean that number of dihydroxyacetone kinase molecules per cell can be increased compared with that of a wild-type strain or non-modified strain, or that the activity of the dihydroxyacetone kinase per molecule can be improved compared with that of a wild-type strain or non-modified strain. The modification is preferably performed so that the dihydroxyacetone kinase activity per cell can be improved to 150% or more, in another example 200% or more, in another example 300% or more, of the activity of a wild-type strain or non-modified strain. Examples of wild-type strains of the microorganism belonging to the family Enterobacteriaceae which can serve as a reference for the comparison include the *Escherichia coli* MG1655 strain (ATCC No. 47076) and W3110 strain (ATCC No. 27325), *Pantoea ananatis* AJ13335 strain (FERM BP-6615), and so forth. The dihydroxyacetone kinase activity can be measured by referring to the method of Johnson E. A. (J. Bacteriol., 1984 October; 160 (1):55-60).

Examples of the gene coding for glycerol dehydrogenase include the *gldA* gene, and one example is the *gldA* gene derived from a microorganism belonging the family Enterobacteriaceae. Examples of the microorganism belonging the family Enterobacteriaceae include *Escherichia coli*. Examples of the gene of *Escherichia coli* include, for example, the *gldA* gene of SEQ ID NO: 1 (complementary strand of the nucleotide numbers 4135955..4137058 of GenBank Accession No. NC\_000913).

Furthermore, homologues of the gene coding for glycerol dehydrogenase can be those cloned on the basis of homology to the gene exemplified above from a bacterium of the genus *Escherichia*, *Enterobacter*, *Klebsiella*, *Serratia*, *Erwinia*, *Yersinia*, *Shigella*, *Salmonella*, *Vibrio*, *Aeromonas*, *Bacillus*, *Staphylococcus*, *Lactobacillus*, *Enterococcus*, *Clostridium*, *Pseudomonas*, *Agrobacterium*, *Citrobacter*, *Corynebacterium*, or the like. Examples of the gene which show high homology to the *gldA* gene of *Escherichia coli* and can be used as the gene coding for glycerol dehydrogenase are mentioned in Table 1.

TABLE 1

Genes showing high homology to <i>gldA</i> gene of <i>Escherichia coli</i> and coding for glycerol dehydrogenase				
Gene	Microorganism	Description	Genbank Accession No.	SEQ ID NO
<i>gldA</i>	<i>Shigella dysenteriae</i> Sd197	Glycerol dehydrogenase (NAD)	YP_405216.1 GI: 82778867	74, 75
<i>gldA</i>	<i>Salmonella typhimurium</i> LT2	Similar to <i>E. coli</i> glycerol dehydrogenase (NAD)	AE008892.1 GI: 16422675	76, 77
<i>gldA</i>	<i>Pseudomonas putida</i>	Glycerol dehydrogenase	AF148496.1 GI: 6552505	78, 79
<i>gldA</i>	<i>Bacillus coagulans</i>	Glycerol dehydrogenase and related enzymes	ZP_01697292.1 GI: 124522908	80, 81

Homology (identity etc.) of amino acid sequences and nucleotide sequences can be determined by using, for example, the algorithm BLAST of Karlin and Altschul (Pro. Natl. Acad. Sci. USA, 90, 5873 (1993)) or FASTA of Pearson (Methods Enzymol., 183, 63 (1990)). Programs called BLASTN and BLASTX have been developed on the basis of this algorithm BLAST (refer to www.ncbi.nlm.nih.gov).

As the gene coding for dihydroxyacetone kinase, the genes designated *dhaKLM* gene, *dak1* gene, *dhaK* gene and *dhbK*



gene can be used. Examples of the gene coding for the enzyme using PEP as a phosphate donor include those genes derived from *Escherichia coli*, such as the dhaK gene of SEQ ID NO: 34 (complementary strand of the nucleotide numbers 1248991..1250061 of GenBank Accession No. NC\_000913), the dhaL gene of SEQ ID NO: 36 (complementary strand of the nucleotide numbers 1248348..1248980 of GenBank Accession No. NC\_000913), and the dhaM gene of SEQ ID NO: 38 (complementary strand of the nucleotide numbers 1246919..1248337 of GenBank Accession No. NC\_000913).

The gene coding for dihydroxyacetone kinase which uses ATP as a phosphate donor can be used, and includes the dak1 gene derived from yeast, the dhbK gene derived from *Agrobacterium* bacteria, and the dhaK gene derived from *Citrobacter* bacteria. Examples of the dak1 gene derived from yeast include the dak1 gene of SEQ ID NO: 3 derived from *Saccharomyces cerevisiae* (GenBank Accession No. NP\_013641.1 GI: 6323570), examples of the dhbK gene derived from *Agrobacterium* bacteria include the dhbK gene of SEQ ID NO: 5 derived from *Agrobacterium tumefaciens* (GenBank Accession No. NP\_357070.1 GI: 15891398), and

examples of the dhaK gene derived from *Citrobacter* bacteria include the dhaK gene of SEQ ID NO: 7 derived from *Citrobacter freundii* (GenBank Accession No. U09771).

Furthermore, homologues of the gene coding for dihydroxyacetone kinase can be those cloned on the basis of homology to the gene exemplified above from a bacterium such as those of the genus *Escherichia*, *Enterobacter*, *Klebsiella*, *Serratia*, *Erwinia*, *Yersinia*, *Shigella*, *Salmonella*, *Vibrio*, *Aeromonas*, *Bacillus*, *Staphylococcus*, *Lactobacillus*, *Enterococcus*, *Clostridium*, *Agrobacterium*, *Citrobacter*, and *Mycobacterium*, yeast such as those of the genus *Saccharomyces*, *Schizosaccharomyces* or *Pichia*, or the like.

In particular, as the gene coding for dihydroxyacetone kinase which uses ATP as a phosphate donor, the following sequences can be used. Genes coding for dihydroxyacetone kinase and showing high homology to the dak1 gene derived from *Saccharomyces cerevisiae* are shown in Table 2, dihydroxyacetone kinase genes showing high homology to the dhbK gene derived from *Agrobacterium tumefaciens* are shown in Table 3, and dihydroxyacetone kinase genes showing high homology to the dhaK gene derived from *Citrobacter freundii* are shown in Table 4.

TABLE 2

Genes coding for dihydroxyacetone kinase and showing high homology to the dak1 gene derived from <i>Saccharomyces cerevisiae</i>				
Gene	Microorganism	Description	Genbank Accession No.	SEQ ID NO
T43702	<i>Schizosaccharomyces pombe</i>	Dihydroxyacetone kinase	gi 3493578 gb AAC78808.1	40, 41
AAC27705	<i>Pichia angusta</i>	Dihydroxyacetone kinase	gi 3171001 gb AAC27705.1	42, 43
AAC39490.1	<i>Pichia pastoris</i>	Dihydroxyacetone kinase	gi 3287486 gb AAC39490.1	44, 45
CAG88710.1	<i>Debaryomyces hansenii</i> CBS767	Dihydroxyacetone kinase	gi 49656075 emb CAG88710.1	46, 47

TABLE 3

Genes coding for dihydroxyacetone kinase and showing high homology to the dhbK gene derived from <i>Agrobacterium tumefaciens</i>				
Gene	Microorganism	Description	Genbank Accession No.	SEQ ID NO
ABF89849.1	<i>Myxococcus xanthus</i> DK 1622	Dihydroxyacetone kinase family protein	gi 108464664 gb ABF89849.1	58, 59
ABB06761.1	<i>Burkholderia</i> sp. 383	Glycerone kinase	gi 77965380 gb ABB06761.1  Glycerone kinase [ <i>Burkholderia</i> sp. 383]	60 61
ABC38950.1	<i>Burkholderia thailandensis</i> E264	Dihydroxyacetone kinase	gi 83654887 gb ABC38950.1	62, 63
EAV65448.1	<i>Burkholderia multivorans</i> ATCC 17616	Glycerone kinase	gi 118658702 gb EAV65448.1	64, 65

TABLE 4

Genes coding for dihydroxyacetone kinase and showing high homology to the dhaK gene derived from <i>Citrobacter freundii</i>				
Gene	Microorganism	Description	Genbank Accession No.	SEQ ID NO
AAX12907.1	<i>Escherichia blattae</i>	Dihydroxyacetone kinase	gi 60099603 gb AAX12907.1	48, 49
EAV82971.1	<i>Enterobacter</i> sp. 638	Dihydroxyacetone kinase	gi 118676428 gb EAV82971.1	50, 51
EAS39398.1	<i>Psychromonas</i> sp. CNPT3	Dihydroxyacetone kinase	gi 90311294 gb EAS39398.1	52, 53



TABLE 4-continued

Genes coding for dihydroxyacetone kinase and showing high homology to the dhaK gene derived from <i>Citrobacter freundii</i>				
Gene	Microorganism	Description	Genbank Accession No.	SEQ ID NO
EAV42339.1	<i>Stappia aggregata</i> IAM 12614	Dihydroxyacetone kinase protein	gi 118434594 gb EVA42339.1	54, 55
CAK08390.1	<i>Rhizobium leguminosarum</i> bv. <i>viciae</i> 3841	Putative dihydroxyacetone kinase	gi 115257295 emb CAK08390.1	56, 57

“Homologues” of the aforementioned genes mean mutant genes derived from other microorganisms, or natural or artificial mutant genes, which show high structural similarity to the aforementioned genes and are able to improve the glycerol dehydrogenase activity and dihydroxyacetone kinase activity when they are introduced into a host or amplified. Homologues of glycerol dehydrogenase and dihydroxyacetone kinase genes mean genes coding for a protein showing a homology of 80% or more, in another example 90% or more, in another example 95% or more, in another example 98% or more, to the total amino acid sequence of SEQ ID NO: 2, 4, 6 or 8 or any of the amino acid sequences encoded by the sequences mentioned in Tables 1 to 4, and having a function of glycerol dehydrogenase or dihydroxyacetone kinase. Whether a gene codes for a protein having glycerol dehydrogenase activity or dihydroxyacetone kinase activity can be confirmed by expressing the gene in a host cell and examining whether the enzymatic activity is increased compared with a non-modified strain according to the aforementioned enzymatic activity measurement method. Moreover, whether a gene is a homologue or not can be confirmed by preparing a gene-disrupted strain in which the corresponding wild-type gene is disrupted, introducing the gene into the disrupted strain, and examining whether the gene complements the function of the wild-type gene, for example, whether the enzymatic activity reduced by the gene disruption is restored.

Furthermore, the genes coding for glycerol dehydrogenase and dihydroxyacetone kinase are not limited to wild-type genes, and they may be mutant or artificially modified genes coding for a protein having an amino acid sequence of SEQ ID NO: 2, 4, 6 or 8 or any of the amino acid sequences mentioned in Table 1 to 4, and which can include substitution, deletion, insertion, addition or the like of one or more amino acid residues at one or more positions so long as the function of encoded glycerol dehydrogenase or dihydroxyacetone kinase is not reduced. Although the number of the “one or several” amino acid residues may differ depending on positions in the three-dimensional structure or types of amino acid residues of the protein, it may be specifically 1 to 20, in another example 1 to 10, in another example 1 to 5, and in another example 1 to 3. These substitutions can be conservative substitutions. The conservative substitution is a mutation wherein substitution takes place mutually among Phe, Trp and Tyr, if the substitution site is an aromatic amino acid; among Leu, Ile and Val, if it is a hydrophobic amino acid; between Gln and Asn, if it is a polar amino acid; among Lys, Arg and His, if it is a basic amino acid; between Asp and Glu, if it is an acidic amino acid; and between Ser and Thr, if it is an amino acid having a hydroxyl group. Examples of the conservative substitution include substitution of Ser or Thr for Ala, substitution of Gln, His or Lys for Arg, substitution of Glu, Gln, Lys, His or Asp for Asn, substitution of Asn, Glu or Gln for Asp, substitution of Ser or Ala for Cys, substitution of

Asn, Glu, Lys, His, Asp or Arg for Gln, substitution of Gly, Asn, Gln, Lys or Asp for Glu, substitution of Pro for Gly, substitution of Asn, Lys, Gln, Arg or Tyr for His, substitution of Leu, Met, Val or Phe for Ile, substitution of Ile, Met, Val or Phe for Leu, substitution of Asn, Glu, Gln, His or Arg for Lys, substitution of Ile, Leu, Val or Phe for Met, substitution of Trp, Tyr, Met, Ile or Leu for Phe, substitution of Thr or Ala for Ser, substitution of Ser or Ala for Thr, substitution of Phe or Tyr for Trp, substitution of His, Phe or Trp for Tyr, and substitution of Met, Ile or Leu for Val. The aforementioned amino acid substitution, deletion, insertion, addition, inversion or the like may be the result of a naturally-occurring mutation due to an individual difference or difference of species (mutant or variant) of a microorganism having the genes coding for glycerol dehydrogenase and dihydroxyacetone kinase.

The genes coding for glycerol dehydrogenase and dihydroxyacetone kinase may also be a DNA which is able to hybridize with a sequence complementary to the nucleotide sequence of SEQ ID NO: 2, 4, 6 or 8 or any of the nucleotide sequences mentioned in Table 1 to 4, or a probe that can be prepared from the nucleotide sequences, under stringent conditions, and codes for a protein having the glycerol dehydrogenase activity or the dihydroxyacetone kinase activity. The “stringent conditions” are conditions under which a so-called specific hybrid is formed, and a non-specific hybrid is not formed. Examples of the stringent condition include those under which highly homologous DNAs hybridize to each other, for example, DNAs not less than 80% homologous, in another example not less than 90% homologous, in another example not less than 95% homologous, and in another example not less than 98% homologous, hybridize to each other, and DNAs less homologous than the above do not hybridize to each other, or conditions of washing of typical Southern hybridization, i.e., washing once, preferably 2 or 3 times, at a salt concentration and temperature corresponding to 1×SSC, 0.1% SDS at 60° C., in another example 0.1×SSC, 0.1% SDS at 60° C., in another example 0.1×SSC, 0.1% SDS at 68° C.

The phrase “intracellular activity of an enzyme increases” can mean when the intracellular activity of the enzyme is increased compared with a wild-type strain (for example, *Escherichia coli* W3110 and MG1655 strains), or a parent strain (strain in which intracellular activities of all the enzymes specified in the present invention are not enhanced), and also includes when the cells have the activity that a wild-type strain or the parent strain does not have.

Examples of the means for increasing the intracellular activity include the following means and combinations thereof. However, the means are not limited to these. As the means for increasing the activities of glycerol dehydrogenase and dihydroxyacetone kinase, any of (1) to (5) can be used, and the same or different means may be used.



(1) Increase in copy number of a gene coding for each protein by transformation using a vector containing the gene.

(2) Increase in copy number of a gene coding for each protein by integration of the gene into chromosome.

(3) Increase in expression amount of a gene coding for each protein by modification of an expression control region of the gene.

(4) Increase in expression amount by modification of a factor which affects on expression control.

(5) Increase in enzymatic activity by introduction of a mutation into a coding region of a gene coding for each protein.

(6) Increase in amount of protein by improvement of translation efficiency.

Henceforth the genes coding for glycerol dehydrogenase and dihydroxyacetone kinase can be each referred to as an objective gene.

(1) Increase in Copy Number of Gene Coding for Each Protein by Transformation Using Vector Containing the Gene

For example, a DNA fragment containing an objective gene can be ligated to a vector which functions in a host microorganism, for example, a vector of multi-copy type, to prepare a recombinant DNA, and the recombinant DNA can be introduced into a microorganism to transform it. The objective gene can be obtained by PCR (polymerase chain reaction, refer to White, T. J. et al., Trends Genet., 5, 185 (1989)) using chromosomal DNA of *Escherichia coli*, yeast, *Citrobacter* bacterium, *Agrobacterium* bacterium or the like as a template. The objective genes derived from other microorganisms can also be obtained from the chromosomal DNA or a chromosomal DNA library of each microorganism by PCR using, as primers, oligonucleotides prepared based on a known objective gene of the microorganism or sequence information of the objective gene or the protein of a microorganism of other species, or hybridization using an oligonucleotide prepared based on such sequence information as mentioned above as a probe. A chromosomal DNA can be prepared from a microorganism that serves as a DNA donor by the method of Saito and Miura (refer to Saito H. and Miura K., Biochem. Biophys. Acta, 72, 619 (1963); Experimental Manual for Biotechnology, edited by The Society for Biotechnology, Japan, pp. 97-98, Baifukan Co., Ltd., 1992) or the like.

Then, the objective gene amplified by PCR can be ligated to a vector DNA which can function in the cell of a host microorganism to prepare a recombinant DNA. Examples of the vector which can function in a cell of host microorganism include vectors which are autonomously replicable in cells of the host microorganism.

Examples of vectors which are autonomously replicable in microorganisms belonging to the family Enterobacteriaceae include pUC19, pUC18, pHSG299, pHSG399, pHSG398, pACYC184, (pHSG and pACYC series vectors are available from Takara Bio), RSF1010 (Gene, vol. 75 (2), p 271-288, 1989), pBR322, pMW219, pMW119 (pMW series vectors are available from Nippon Gene), pSTV28, pSTV29 (Takara Bio) and so forth. A phage DNA vector can also be used.

To prepare recombinant DNA by ligating any of the genes to the above-mentioned vector, the vector is digested with a restriction enzyme corresponding to termini of a DNA fragment containing the objective gene. Ligation is generally performed by using a ligase such as T4 DNA ligase. As methods for digesting and ligating DNA, preparation of chromosomal DNA, PCR, preparation of plasmid DNA, transformation, design of oligonucleotides to be used as primers and so forth, methods well known to a person skilled in the art can be employed. These methods are described in Sambrook, J.,

Fritsch, E. F., and Maniatis, T., "Molecular Cloning A Laboratory Manual, Second Edition", Cold Spring Harbor Laboratory Press, (1989), and so forth.

The recombinant DNA prepared as described above may be introduced into a bacterium in accordance with a conventional known transformation method. Examples include electroporation (Canadian Journal of Microbiology, 43, 197 (1997)). It is also possible to use a method of increasing the DNA permeability by treating recipient cells with calcium chloride, which is reported for *Escherichia coli* K-12 (Mandel, M. and Higa, A., J. Mol. Biol., 53, 159 (1970)), or a method of introducing a DNA into a competent cell prepared from a cell at proliferation stage, which is reported for *Bacillus subtilis* (Duncan, C. H., Wilson, G. A and Young, F. E., Gene, 1, 153 (1977)).

(2) Increase in Copy Number of Gene Coding for Each Protein by Integration of the Gene into Chromosome

Increase of intracellular activity of each enzyme can be achieved by increasing the copy number of the objective gene by introducing the objective gene into chromosomal DNA of the microorganism. Introduction of the objective gene into the chromosomal DNA of the microorganism can be attained by homologous recombination using a target sequence present on the chromosomal DNA in multiple copies. As such a sequence present on a chromosomal DNA in multiple copies, a repetitive DNA or an inverted repeat present on the termini of a transposing element can be used. Alternatively, as disclosed in Japanese Patent Laid-open (Kokai) No. 2-109985, the objective gene can be introduced into the chromosomal DNA by inserting the gene into a transposon, and transferring it so that the gene is integrated into the chromosomal DNA. Moreover, it is also possible to introduce an objective gene into a chromosome by using the Red driven integration method (WO2005/010175). An objective gene can also be introduced into a chromosome by transduction using a phage such as P1 phage, or by using a vector for conjugative transfer. Transfer of a gene to a chromosome can be confirmed by performing Southern hybridization using a part of the gene as a probe. Amplification of copy number can be confirmed by Southern hybridization using a probe complementary to the objective gene. Although the copy number may be amplified to any extent so long as it is amplified by one or more copies, the gene coding for glycerol dehydrogenase can be amplified by two or more copies, in another example three or more copies, in another example five or more copies, and the gene coding for dihydroxyacetone kinase can be amplified by two or more copies, in another example three or more copies, in another example five or more copies. When the gene is not native to the chosen host microorganism, any number of copies can be introduced, so long as one or more copies are introduced.

(3) Increase in Expression Amount of Gene Coding for Each Protein by Modification of Expression Control Region of the Gene

Furthermore, besides increasing the copy number of objective gene mentioned above, increasing the intracellular activity of each enzyme can be achieved by replacing an expression regulatory sequence such as a promoter of the gene on a chromosomal DNA or on a plasmid with a stronger promoter by the method described in WO0/18935. As strong promoters, for example, there are known the lac promoter, trp promoter, trc promoter, lambda phage PR promoter, PL promoter, lpp promoter, T7 promoter, tet promoter, and so forth. To amplify glycerol dehydrogenase, the tacM promoter (SEQ ID NO: 10) is one example. dhaK, dhaL and dhaM coding for dihydroxyacetone kinase of *Escherichia coli* take an operon



structure, and expression amounts of all the three genes are improved by enhancing the promoter locating upstream of dhaK.

Moreover, it is also possible to introduce nucleotide substitution or the like into a promoter region of an objective gene to modify it into a stronger promoter. Methods for evaluating potency of promoters and examples of potent promoters are described in the paper of Goldstein et al. (Prokaryotic promoters in biotechnology, *Biotechnol. Annu. Rev.*, 1995, 1, 105-128), and so forth. Furthermore, it is known that substitution of several nucleotides in the spacer region between the ribosome binding site (RBS) and the start codon, in particular, in the region immediately upstream of the start codon, significantly affects the translation efficiency of mRNA, and such a region can also be modified. Expression of the objective gene is enhanced by such substitution or modification of promoter.

As for substitution of a stronger promoter for a promoter on a chromosome, a promoter located upstream of the objective gene on a genome can be replaced with a stronger promoter by transforming a microorganism belonging to the family Enterobacteriaceae with a DNA containing the stronger promoter amplified by PCR or the like to cause recombination of the stronger promoter and the wild-type promoter on the genome. For such gene substitution utilizing homologous recombination, there can be utilized a method called Red-driven integration (Datsenko, K. A, and Wanner, B. L., *Proc. Natl. Acad. Sci. USA*, 97:6640-6645 (2000)), a method of using a linear DNA such as a method utilizing the Red driven integration in combination with an excisive system derived from  $\lambda$  phage (Cho, E. H., Gumpert, R. I., Gardner, J. F., *J. Bacteriol.*, 184:5200-5203 (2002)) (refer to WO2005/010175), a method of using a plasmid containing a temperature sensitive replication origin (Datsenko, K. A, and Wanner, B. L., *Proc. Natl. Acad. Sci. USA*, 97:6640-6645 (2000), U.S. Pat. No. 6,303,383, Japanese Patent Laid-open No. 05-007491), and so forth.

#### (4) Increase in Expression Amount by Modification of Factor which Affects on Expression Control

Increase in expression amount by modification of a factor which affects on expression control can be attained by amplifying a gene coding for an activator which increases expression of the genes coding for glycerol dehydrogenase and dihydroxyacetone kinase, or by deleting or attenuating a gene coding for a regulator which reduces expression of the genes. Examples of the activator of dhaKLM coding for dihydroxyacetone kinase include, for example, dhaR (SEQ ID NO: 66, the nucleotide numbers 1250289..1252208 of GenBank Accession No. NC\_000913), and expression amount of dhaKLM coding for dihydroxyacetone kinase is increased by a mutation of the dhaR gene (1: *EMBO J.*, 2005 Jan. 26, 24 (2):283-93). The expression amount of dhaKLM coding for dihydroxyacetone kinase is also increased by disruption of the ptsI gene (SEQ ID NO: 86, the nucleotide numbers 2532088..2533815 of GenBank Accession No. NC\_000913) (Microbiology, 147 (2001) 247-253)

#### (5) Increase in Enzymatic Activity by Introduction of Mutation into Coding Region of Gene Coding for Each Protein

Furthermore, increase of the activities of glycerol dehydrogenase and dihydroxyacetone kinase can also be achieved by introducing a mutation which increases specific activities of the proteins or improves substrate specificities of the enzymes into the coding regions of the objective genes.

Such a gene coding for each enzyme having a mutation can be obtained by, for example, modifying the nucleotide sequence of the SEQ ID NO: 1, 3, 5 or 7, or a coding region

in any of the nucleotide sequences mentioned in Tables 1 to 4, so that amino acid residues of a specific part of the encoded protein include substitution, deletion, insertion, addition or the like of amino acid residues. Furthermore, it can also be obtained by the conventionally known mutagenizing treatments described below. As for the mutagenizing treatments, by a method of treating the nucleotide sequence of the SEQ ID NO: 1, 3, 5 or 7, any of the nucleotide sequences mentioned in Tables 1 to 4, or a coding region sequence in any of these with hydroxylamine or the like in vitro, a method of treating a microorganism such as microorganisms belonging to the family Enterobacteriaceae containing the gene with ultraviolet radiation or a mutagenizing agent used for usual mutagenizing treatment such as N-methyl-N'-nitro-N-nitrosoguanidine (NTG) or ethyl methanesulfonate (EMS), error-prone PCR (Cadwell, R. C., *PCR Meth. Appl.*, 2, 28 (1992)), DNA shuffling (Stemmer, W. P., *Nature*, 370, 389 (1994)), or StEP-PCR (Zhao, H., *Nature Biotechnol.*, 16, 258 (1998)), a mutation can be artificially introduced into the genes coding for glycerol dehydrogenase and dihydroxyacetone kinase by gene recombination to obtain genes coding for highly active glycerol dehydrogenase and dihydroxyacetone kinase. Whether such mutant enzymes code for glycerol dehydrogenase and dihydroxyacetone kinase can be confirmed by, for example, introducing the genes into a microorganism belonging to the family Enterobacteriaceae and having an L-amino acid-producing ability, culturing it in a medium containing glycerol as a carbon source, and confirming whether the L-amino acid-producing ability is improved, or measuring the enzyme activities by the aforementioned methods.

#### (6) Increase in Amount of Protein by Improvement of Translation Efficiency

An increase in the amount of protein by improvement of translation efficiency can be attained by increasing the tRNA corresponding to codons less frequently used in the host, or by modifying the objective gene so that it has optimal codons according to frequency of use of codons in the host (Gene 85, 109-114 (1989), *Biochemistry*, 31, 2598-2608 (1992), *J. Bacteriol.*, 175, 716-722 (1993), *Protein Expression and Purification*, 50, 49-57 (2006)). An increase in the amount of the objective protein compared with a non-modifying strain or wild-type strain can be confirmed by, for example, detection by Western blotting using antibodies (*Molecular Cloning* (Cold Spring Harbor Laboratory Press, Cold spring Harbor (USA), 2001)).

The microorganism can be modified to increase glycerol uptake activity, in addition to enhancing glycerol dehydrogenase and dihydroxyacetone kinase. The glycerol uptake activity can mean an activity for incorporating glycerol into cytoplasm, and a glycerol facilitator which is a membrane protein is also involved. Examples of the gene coding for the glycerol facilitator include, for example, the glpF gene of *Escherichia coli* (SEQ ID NO: 16, complementary strand of the nucleotide numbers 4115268..4116113 of GenBank Accession No. NC\_000913).

The gene coding for the glycerol facilitator may be a DNA which hybridizes with a complementary sequence of the nucleotide sequence of SEQ ID NO: 16 or a probe which can be prepared from the complementary sequence under a stringent condition, and codes for a protein having the glycerol uptake activity. Examples also include a DNA coding for the protein of SEQ ID NO: 17. The protein can be a protein showing a homology of 80% or more, in another example 90% or more, in another example 95% or more, and in another example 98% or more, to the total amino acid sequence of SEQ ID NO: 17, so long as it increases the glycerol uptake



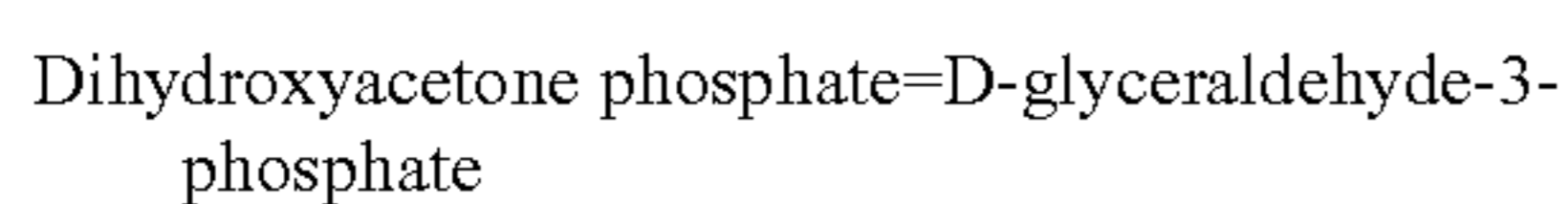
ability in a microorganism belonging to the family Enterobacteriaceae, when it is introduced into the microorganism.

Moreover, the gene may be a DNA coding for a protein having an amino acid sequence of SEQ ID NO: 17 including substitution, deletion, insertion, addition or the like of one or several amino acid residues, so long as the glycerol uptake activity is not reduced. The activity can be increased by a method similar to the aforementioned methods for enhancing glycerol dehydrogenase and dihydroxyacetone kinase.

The glycerol uptake activity can be measured by using the transport assay method using a membrane protein (Voegele, R. T., Sweet, G. D., and Boos, W. J., *Bacteriol.*, 175:1087-1094 (1993)).

The microorganism can be modified to increase activities of one or more enzymes including triosephosphate isomerase, fructose biphosphate aldolase, fructose-1,6-bisphosphatase and fructose-6-phosphate aldolase, in addition to enhancing glycerol dehydrogenase and dihydroxyacetone kinase and the enhancement of glycerol uptake activity.

Triosephosphate isomerase is an enzyme which catalyzes a reaction which reversibly converts dihydroxyacetone phosphate into glyceraldehyde-3-phosphate (EC:5.3.1.1).



The phrase "being modified to increase the triosephosphate isomerase activity" can mean that the number of the triosephosphate isomerase molecules per cell can be increased compared with that of a wild-type strain or non-modified strain, or when the activity of the triosephosphate isomerase per molecule can be improved compared with that of a wild-type strain or non-modified strain. The modification can be performed so that the triosephosphate isomerase activity per cell can be improved to 150% or more, in another example 200% or more, in another example 300% or more, of the activity of a wild-type strain or non-modified strain. Examples of wild-type strains of the microorganism belonging to the family Enterobacteriaceae which can serve as a reference for comparison include the *Escherichia coli* MG1655 strain (ATCC No. 47076) and W3110 strain (ATCC No. 27325), *Pantoea ananatis* AJ13335 strain (FERM BP-6615), and so forth.

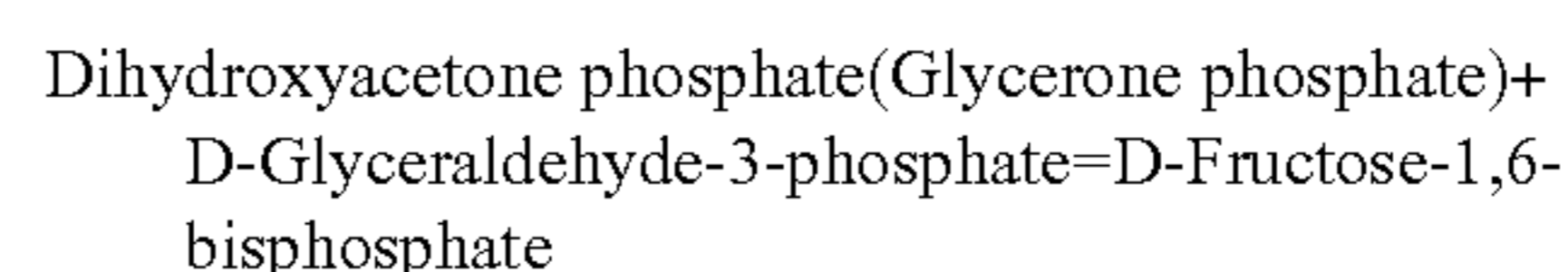
Examples of the gene coding for triosephosphate isomerase include the *tpiA* gene derived from *Escherichia coli* (SEQ ID NO: 18, complementary strand of the nucleotide numbers 4108763..4109530 of GenBank Accession No. NC\_000913).

The gene coding for triosephosphate isomerase may be a DNA which hybridizes with a complementary sequence of the nucleotide sequence of SEQ ID NO: 18 or a probe which can be prepared from the complementary sequence under stringent conditions, and codes for a protein having the triosephosphate isomerase activity. Examples also include a DNA coding for the protein of SEQ ID NO: 19. The protein can be a protein showing a homology of 80% or more, in another example 90% or more, in another example 95% or more, in another example 98% or more, to the total amino acid sequence of SEQ ID NO: 19, so long as it shows increased triosephosphate isomerase activity in a microorganism belonging to the family Enterobacteriaceae, when it is introduced into the microorganism.

Moreover, the gene may be a DNA coding for a protein having an amino acid sequence of SEQ ID NO: 19 including substitution, deletion, insertion, addition or the like of one or several amino acid residues, so long as the triosephosphate isomerase activity is not reduced.

The triosephosphate isomerase activity can be measured by using the method of Andersen and Cooper (*FEBS Lett.*, 4, 19-20 (1969)). The activity can be increased by methods similar to the aforementioned methods for enhancing glycerol dehydrogenase and dihydroxyacetone kinase.

Fructose biphosphate aldolase" is an enzyme which reversibly catalyzes the following reaction which converts dihydroxyacetone phosphate and glyceraldehyde-3-phosphate into D-fructose-1,6-bisphosphate (EC:4.1.2.13).



The phrase "being modified to increase the fructose biphosphate aldolase activity" can mean that number of the fructose biphosphate aldolase molecules per cell can be increased compared with that of a wild-type strain or non-modified strain, or when the activity of the fructose biphosphate aldolase per molecule can be improved compared with that of a wild-type strain or non-modified strain. The modification can be performed so that the fructose biphosphate aldolase activity per cell can be improved to 150% or more, in another example 200% or more, in another example 300% or more, of the activity of a wild-type strain or non-modified strain. Examples of wild-type strains of the microorganism belonging to the family Enterobacteriaceae which can serve as a reference for the comparison include the *Escherichia coli* MG1655 strain (ATCC No. 47076) and W3110 strain (ATCC No. 27325), *Pantoea ananatis* AJ13335 strain (FERM BP-6615), and so forth.

Examples of the gene coding for fructose biphosphate aldolase include the *fbaA* gene derived from *Escherichia coli* (SEQ ID NO: 20, complementary strand of the nucleotide numbers 3068187..3069266 of GenBank Accession No. NC\_000913) and the *fbaB* gene derived from *Escherichia coli* (SEQ ID NO: 72, complementary strand of the nucleotide numbers 2175534..2176586 of GenBank Accession No. NC\_000913).

The gene coding for fructose biphosphate aldolase can be a DNA which hybridizes with a complementary sequence of the nucleotide sequence of SEQ ID NO: 20 or 72 or a probe which can be prepared from the complementary sequence under a stringent condition, and codes for a protein having the fructose biphosphate aldolase activity. Examples also include a DNA coding for the protein of SEQ ID NO: 21 or 73. The protein may be show a homology of 80% or more, in another example 90% or more, in another example 95% or more, in another example 98% or more, to the total amino acid sequence of SEQ ID NO: 21, so long as it shows increased fructose biphosphate aldolase activity in a microorganism belonging to the family Enterobacteriaceae, when it is introduced into the microorganism.

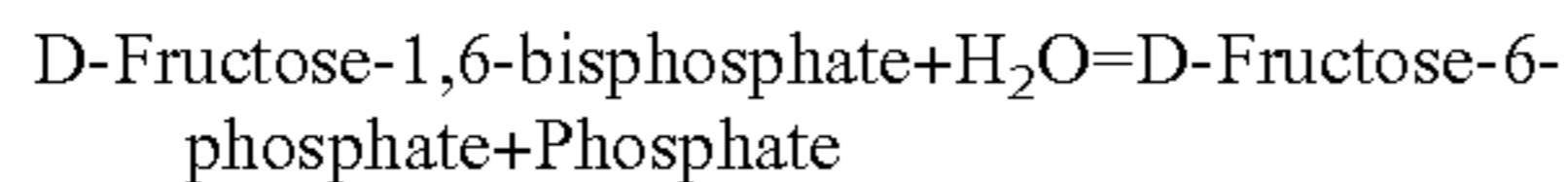
Moreover, the gene can be a DNA coding for a protein having an amino acid sequence of SEQ ID NO: 21 or 73, but which can include substitution, deletion, insertion, addition or the like of one or several amino acid residues, so long as the fructose biphosphate aldolase activity is not reduced.

The fructose biphosphate aldolase activity can be measured by using the method of Richard & Rutter (*J. Biol. Chem.*, 236, 3177-3184). The activity can be increased by methods similar to the aforementioned methods for enhancing glycerol dehydrogenase and dihydroxyacetone kinase.

The fructose-1,6-bisphosphatase is an enzyme which reversibly catalyzes the following reaction that converts



D-fructose-1,6-bisphosphate into D-fructose-6-phosphate (EC:3.1.3.11).



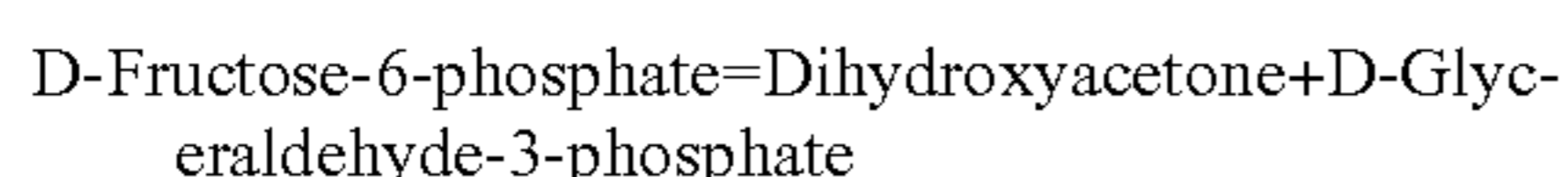
The phrase “being modified to increase the fructose-1,6-bisphosphatase activity” can mean that the number of the fructose-1,6-bisphosphatase molecules per cell can be increased compared with that of a wild-type strain or non-modified strain, or when the activity of the fructose-1,6-bisphosphatase per molecule can be improved compared with that of a wild-type strain or non-modified strain. The modification can be performed so that the fructose-1,6-bisphosphatase activity per cell can be improved to 150% or more, in another example 200% or more, in another example 300% or more, of the activity of a wild-type strain or non-modified strain. Examples of wild-type strains of the microorganism belonging to the family Enterobacteriaceae which serve as a reference for the comparison include the *Escherichia coli* MG1655 strain (ATCC No. 47076) and W3110 strain (ATCC No. 27325), *Pantoea ananatis* AJ13335 strain (FERM BP-6615), and so forth.

Examples of the gene coding for fructose-1,6-bisphosphatase include the *glpX* gene (SEQ ID NO: 22, complementary strand of the nucleotide numbers 4112592..4113602 of GenBank Accession No. NC\_000913), the *fbp* gene (SEQ ID NO: 82, the nucleotide numbers 4452634..4453632 of GenBank Accession No. NC\_000913), and the *ybhA* gene (SEQ ID NO: 84, the nucleotide numbers 796836..7976554 of GenBank Accession No. NC\_000913), which are derived from *Escherichia coli*. The gene coding for the fructose-1,6-bisphosphatase may be a DNA which hybridizes with a complementary sequence of the nucleotide sequence of SEQ ID NO: 22, 82 or 84 or a probe which can be prepared from the complementary sequence under a stringent condition, and codes for a protein having the fructose-1,6-bisphosphatase activity. Examples also include a DNA coding for the protein of SEQ ID NO: 23, 83 or 85. The protein may show a homology of 80% or more, in another example 90% or more, in another example 95% or more, in another example 98% or more, to the total amino acid sequence of SEQ ID NO: 23, 83 or 85, so long as it shows increased fructose-1,6-bisphosphatase activity in a microorganism belonging to the family Enterobacteriaceae, when it is introduced into the microorganism.

Moreover, the gene can be a DNA coding for a protein having an amino acid sequence of SEQ ID NO: 23, 83 or 85, but can include substitution, deletion, insertion, addition or the like of one or several amino acid residues, so long as the fructose-1,6-bisphosphatase activity is not reduced.

The fructose-1,6-bisphosphatase activity can be measured by using the method of Nakajima et al. (Protein Nucleic Enzyme, 22, 1585-1589). The activity can be increased by methods similar to the aforementioned methods for enhancing glycerol dehydrogenase and dihydroxyacetone kinase.

In the present invention, “fructose-6-phosphate aldolase” is an enzyme which reversibly catalyzes the following reaction that converts dihydroxyacetone into fructose-6-phosphate.



The phrase “being modified to increase the fructose-6-phosphate aldolase activity” can mean that the number of the fructose-6-phosphate aldolase molecules per cell can be increased compared with that of a wild-type strain or non-modified strain, or when the activity of the fructose-6-phos-

phate aldolase per molecule can be improved compared with that of a wild-type strain or non-modified strain. The modification can be performed so that the fructose-6-phosphate aldolase activity per cell can be improved to 150% or more, in another example 200% or more, and in another example 300% or more, of the activity observed in a wild-type strain or non-modified strain. Examples of wild-type strains of the microorganism belonging to the family Enterobacteriaceae which can serve as a reference for comparison include the *Escherichia coli* MG1655 strain (ATCC No. 47076) and W3110 strain (ATCC No. 27325), *Pantoea ananatis* AJ13335 strain (FERM BP-6615), and so forth.

Examples of the gene coding for fructose-6-phosphate aldolase include the *fsaA* gene coding for type I aldolase (SEQ ID NO: 68, the nucleotide numbers 862865..863527 of GenBank Accession No. NC\_000913), and the *fsaB* gene (*talC* gene) (SEQ ID NO: 70, complementary strand of the nucleotide numbers 4137069..4137731 of GenBank Accession No. NC\_000913) coding for type II aldolase, which are derived from *Escherichia coli*.

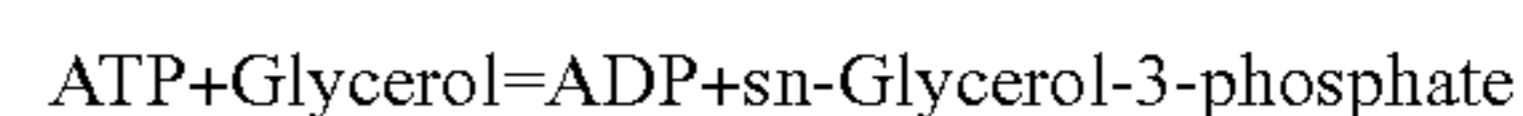
The gene coding for fructose-6-phosphate aldolase can be a DNA which hybridizes with a complementary sequence of the nucleotide sequence of SEQ ID NO: 68 or 70 or a probe which can be prepared from the complementary sequence under stringent conditions, and codes for a protein having the fructose-6-phosphate aldolase activity. Examples also include a DNA coding for the protein of SEQ ID NO: 69 or 71. The protein may be a protein showing a homology of 80% or more, in another example 90% or more, in another example 95% or more, and in another example 98% or more, to the total amino acid sequence of SEQ ID NO: 69 or 71, so long as it shows increased fructose-6-phosphate aldolase activity in a microorganism belonging to the family Enterobacteriaceae, when it is introduced into the microorganism.

Moreover, the gene may be a DNA coding for a protein having an amino acid sequence of SEQ ID NO: 69 or 71, but which can include substitution, deletion, insertion, addition or the like of one or several amino acid residues, so long as the fructose-6-phosphate aldolase activity is not reduced.

The fructose-6-phosphate aldolase activity can be measured by using the method of Schurmann M., Sprenger G. A. et al. (J. Biol. Chem., 2001 Apr. 6, 276 (14): 11055-61). The activity can be increased by methods similar to the aforementioned methods for enhancing glycerol dehydrogenase and dihydroxyacetone kinase.

The microorganism can be modified to reduce glycerol kinase and/or membrane-binding type glycerol-3-phosphate dehydrogenase activity, in addition to the enhancement of glycerol dehydrogenase and dihydroxyacetone kinase, the enhancement of the glycerol uptake activity, and the enhancement of activities of one or more kinds of enzymes including triosephosphate isomerase, fructose bisphosphate aldolase, fructose-1,6-bisphosphatase and fructose-6-phosphate aldolase.

“Glycerol kinase” can mean an enzyme which reversibly catalyzes the following reaction that generates glycerol-3-phosphate and ADP from glycerol and ATP (EC2.7.1.30)



The phrase “being modified to reduce the glycerol kinase activity” can mean that the number of the glycerol kinase molecules per cell can be decreased compared with that of a wild-type strain or non-modified strain, or a state that the activity of the glycerol kinase per molecule can be reduced compared with that of a wild-type strain or non-modified strain. The modification can be performed so that the glycerol kinase activity per cell can be reduced to 70% or less, in

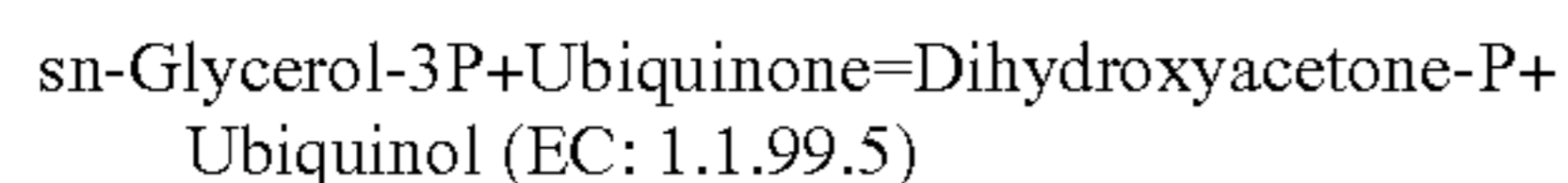


another example 50% or less, in another example 30% or less, in another example 20% or less, of the activity of a wild-type strain or non-modified strain, and the enzymatic activity can be deleted. The enzymatic activity can be decreased by reducing the expression amount of the gene coding for the enzyme. Reduction of the expression amount of the gene includes reduction of the transcription amount of mRNA transcribed from the gene and reduction of translation amount of this mRNA.

Complete elimination of the production of the enzyme protein molecule or reduction or deletion of the activity per enzyme protein molecule is attained by disrupting the gene coding for the enzyme. Examples of wild-type strains of the microorganism belonging to the family Enterobacteriaceae which can serve as a reference for comparison include the *Escherichia coli* MG1655 strain (ATCC No. 47076) and W3110 strain (ATCC No. 27325), *Pantoea ananatis* AJ13335 strain (FERM BP-6615), and so forth.

Examples of the gene coding for glycerol kinase include the glpK gene (SEQ ID NO: 24, complementary strand of the nucleotide numbers 4113737..4115245 of GenBank Accession No. NC\_000913) derived from *Escherichia coli*. The enzymatic activity of glycerol kinase can be measured by the method of Thorner & Paulus (The Enzymes, 3rd ed., 8, 487-508).

“Membrane-binding type glycerol-3-phosphate dehydrogenase” is an enzyme which catalyzes the oxidation reaction converting glycerol-3-phosphate to dihydroxyacetone phosphate, and is an enzyme which reversibly catalyzes the following reaction.



The phrase “being modified to reduce the membrane-binding type glycerol-3-phosphate dehydrogenase activity” can mean that the number of the membrane-binding type glycerol-3-phosphate dehydrogenase molecules per cell is decreased compared with that of a wild-type strain or non-modified strain, or a state that the activity of the membrane-binding type glycerol-3-phosphate dehydrogenase per molecule is reduced compared with that of a wild-type strain or non-modified strain. The modification can be performed so that the membrane-binding type glycerol-3-phosphate dehydrogenase activity per cell is reduced to 70% or less, in another example 50% or less, in another example 30% or less, of the activity of a wild-type strain or non-modified strain, and the enzymatic activity may be deleted. The enzymatic activity can be decreased by reducing the expression amount of the gene coding for the enzyme. Examples of wild-type strains of the microorganism belonging to the family Enterobacteriaceae which can serve as a reference for comparison include the *Escherichia coli* MG1655 strain (ATCC No. 47076) and W3110 strain (ATCC No. 27325), *Pantoea ananatis* AJ13335 strain (FERM BP-6615), and so forth.

The membrane-binding type glycerol-3-phosphate dehydrogenase is encoded by the glpABC operon and the glpD gene, and examples of the glpA gene of *Escherichia coli* include the sequence of SEQ ID NO: 26 (the nucleotide numbers 2350669..2352297 of GenBank Accession No. NC\_000913), examples of the glpB gene of *Escherichia coli* include the sequence of SEQ ID NO: 28 (the nucleotide numbers 2352287..2353546 of GenBank Accession No. NC\_000913), examples of the glpC gene of *Escherichia coli* include the sequence of SEQ ID NO: 30 (the nucleotide numbers 2353543..2354733 of GenBank Accession No. NC\_000913), and examples of the glpD gene of *Escherichia*

*coli* include the sequence of SEQ ID NO: 32 (the nucleotide numbers 3560036..3561541 of GenBank Accession No. NC\_000913).

Reduction of activity of an objective enzyme such as glycerol kinase and glycerol-3-phosphate dehydrogenase mentioned above can be attained by

(1) reduction or deletion of the enzymatic activity by introduction of a mutation into a coding region of a gene coding for the objective enzyme, or

(2) reduction or deletion of the enzymatic activity by modification of an expression control sequence of a gene coding for the objective enzyme.

(1) Reduction or Deletion of Enzymatic Activity by Introduction of Mutation into Coding Region of Gene Coding for Objective Enzyme

Introduction of a mutation into a coding region of a gene coding for an objective enzyme can be attained by introducing a mutation for an amino acid substitution (missense mutation), a stop codon (nonsense mutation), or a frame shift mutation which adds or deletes one or two nucleotides into a region of the objective gene coding for the enzyme on a chromosome by genetic recombination (Journal of Biological Chemistry, 272:8611-8617 (1997); Proceedings of the National Academy of Sciences, USA, 95 5511-5515 (1998); Journal of Biological Chemistry, 266, 20833-20839 (1991)). It can also be attained by deleting a part or all of the gene in the coding region. Specifically, it can be attained by introducing a mutation into a part of DNA of SEQ ID NO: 24, 26, 28, 30 or 32, or deleting a part or all of such DNA.

As for the introduction of mutation, the enzymatic activity can also be reduced or deleted by constructing a gene coding for a mutant enzyme of which the coding region is deleted or introduced with a mutation, and substituting the constructed gene for the normal gene on a chromosome by homologous recombination or the like, or by introducing a transposon or IS factor into the gene.

For introduction of such mutations for reducing or deleting activity of an enzyme as described above into a gene by genetic recombination, for example, the following methods are used. By modifying a partial sequence of an objective gene to prepare a mutant gene designed so that it does not produce an enzyme that functions normally, and transforming a microorganism belonging to the family Enterobacteriaceae with a DNA containing the gene to cause recombination of the mutant gene and the corresponding gene on a chromosome, the objective gene on a chromosome can be replaced with the mutant gene. For such gene substitution utilizing homologous recombination, there can be utilized a method called Red-driven integration (Datsenko, K. A, and Wanner, B. L., Proc. Natl. Acad. Sci. USA, 97:6640-6645 (2000)), a method of using a linear DNA such as a method utilizing the Red driven integration in combination with an excisive system derived from  $\lambda$  phage (Cho, E. H., Gumport, R. I., Gardner, J. F., J. Bacteriol., 184:5200-5203 (2002)), a method of using a plasmid containing a temperature sensitive replication origin (Datsenko, K. A, and Wanner, B. L., Proc. Natl. Acad. Sci. USA, 97:6640-6645 (2000), U.S. Pat. No. 6,303,383, Japanese Patent Laid-open No. 05-007491), and so forth. Moreover, such site-specific mutagenesis based on gene substitution utilizing homologous recombination as described above can also be performed by using a plasmid which is not able to replicate in a host. Moreover, reduction or deletion of the enzymatic activity can also be attained by modification for introducing a mutation into a coding region of an objective gene caused by a usual mutation treatment based on X-ray or ultraviolet irradiation or use of a mutation agent such as N-methyl-N'-nitro-N-nitrosoguanidine.



(2) Reduction or Deletion of Enzymatic Activity by Modification of Expression Control Sequence of Gene Coding for Objective Enzyme

Reduction or deletion of an enzymatic activity by modification of an expression control sequence of a gene coding for an objective enzyme can also be attained by reducing the expression amount by introducing a mutation into an expression control sequence such as a promoter and SD sequence on a chromosomal DNA, by amplifying a gene coding for a regulator which reduces expression of the gene, or by deleting or attenuating a gene coding for an activator which improves expression of the gene. Methods for evaluating potency of promoters and examples of potent promoters are described in the paper of Goldstein et al. (Prokaryotic promoters in biotechnology, *Biotechnol. Annu. Rev.*, 1995, 1, 105-128), and so forth. Furthermore, it is known that by replacing several nucleotides in the spacer region between the ribosome binding site (RBS) and the start codon, in particular, in the region immediately upstream from the start codon, the translation efficiency of mRNA can be significantly affected, and such a region can also be modified. In particular, the *glpA*, *B* and *C* genes take an operon structure, and therefore the expression amount thereof can be reduced by introducing a mutation into an expression control region such as a promoter region locating upstream of *glpA*.

#### <2> Production Method

An exemplary production method of the present invention is a method for producing an L-amino acid, which includes culturing a microorganism belonging to the family *Enterobacteriaceae*, having an L-amino acid-producing ability and modified to increase glycerol dehydrogenase and dihydroxyacetone kinase activities in a medium containing glycerol as a carbon source to produce and accumulate an L-amino acid in the medium or cells, and collecting the L-amino acid from the medium or the cells. Any batch culture, fed-batch culture, or continuous culture may be used. Glycerol contained in the medium can be contained in the starting medium, feed medium, or both.

The aforementioned fed-batch culture refers to a culture method in which the medium is continuously or intermittently fed into the culture vessel, and the medium is not extracted until the end of the culture. The continuous culture can mean a method in which the medium is continuously or intermittently fed into the culture vessel, and the medium is extracted from the vessel (usually in a volume equal to the volume of the fed medium) at the same time. The starting medium can mean a medium used in batch culture before feeding the feed medium in the fed-batch culture or continuous culture (medium used at the start of the culture). The feed medium can mean a medium which is supplied to the fermentation tank in the fed-batch culture or continuous culture. The batch culture can mean a method in which fresh medium is prepared for every culture, a strain is inoculated into the fresh medium, and medium is not added thereafter until harvest.

The glycerol present in the medium can be the sole carbon source, or a mixed medium can be used which contains other carbon sources in addition to glycerol. Saccharides can be used such as glucose, fructose, sucrose, lactose, galactose, blackstrap molasses, and a sugar solution obtained by hydrolysis of starch hydrolysate or biomass, alcohols such as ethanol, and organic acids such as fumaric acid, citric acid, and succinic acid. When a mixed medium is used, glycerol can be present in the medium at a ratio of 50% or more, in another example 60% or more, in another example 70% or more, in another example 80% or more, in another example 90% or more. Glycerol obtained as a by-product of biodiesel

fuel production can also be used (Mu Y, et al, *Biotechnol Lett.*, 28, 1755-91759 (2006); Haas M. J., et al., *Bioresour. Technol.*, 97, 4, 671-8678 (2006)).

As for other components which can be added to the medium, a typical medium can contain, besides the carbon source, a nitrogen source, inorganic ions, and other organic components as required can be used. As the nitrogen source, ammonia, ammonium salts such as ammonium sulfate, ammonium carbonate, ammonium chloride, ammonium phosphate, ammonium acetate and urea, nitrates, and so forth can be used. Ammonia gas and aqueous ammonia used to adjust the pH can also be utilized as the nitrogen source. Furthermore, peptone, yeast extract, meat extract, malt extract, corn steep liquor, soybean hydrolysate, and so forth can also be utilized. The medium can contain one or more of these nitrogen sources. These nitrogen sources can also be used for both the starting medium and the feed medium. Furthermore, the same nitrogen source can be used for both the starting medium and the feed medium, or the nitrogen source of the feed medium may be different from that of the starting medium.

The medium can contain a phosphoric acid source and a sulfur source in addition to the carbon source, the nitrogen source and sulfur. As the phosphoric acid source, potassium dihydrogenphosphate, dipotassium hydrogenphosphate, phosphate polymers such as pyrophosphoric acid and so forth can be utilized. The sulfur source may be any sulfur source so long as it contains a sulfur atom, and salts of sulfuric acid such as sulfates, thiosulfates and sulfites and sulfur-containing amino acids such as cysteine, cystine and glutathione are examples. Among these, ammonium sulfate is another example.

Furthermore, the medium can contain a growth promoting factor (nutrient having a growth promoting effect) in addition to the carbon source, the nitrogen source and sulfur. As the growth promoting factor, trace metals, amino acids, vitamins, nucleic acids as well as peptone, casamino acid, yeast extract, soybean protein degradation product and so forth containing the foregoing substances can be used. Examples of the trace metals include iron, manganese, magnesium, calcium and so forth. Examples of the vitamins include vitamin B<sub>1</sub>, vitamin B<sub>2</sub>, vitamin B<sub>6</sub>, nicotinic acid, nicotinic acid amide, vitamin B<sub>12</sub> and so forth. These growth promoting factors may be contained in the starting medium or the feed medium.

When an auxotrophic mutant that requires an amino acid or the like for growth thereof is used, the required nutrient should be supplemented to the medium. In particular, since L-lysine biosynthetic pathway is enhanced and L-lysine degrading ability is attenuated in many of L-lysine-producing bacteria as described below, one or more types of substances, such as L-threonine, L-homoserine, L-isoleucine and L-methionine can be added.

The starting medium and the feed medium can have the same or different compositions. Furthermore, the starting medium and the feed medium may have the same or different sulfur concentrations. Furthermore, when the feed medium is fed at multiple stages, the compositions of the feed media may be the same or different.

The culture is preferably performed as an aeration culture at a fermentation temperature of 20 to 45° C., particularly preferably at 30 to 42° C. The oxygen concentration is adjusted to 5 to 50%, desirably about 10%. Furthermore, the aeration culture is preferably performed with pH adjusted to 5 to 9. If pH drops during the culture, for example, calcium carbonate or an alkali such as ammonia gas and aqueous ammonia can be added to neutralize the culture. When the culture is performed for about 10 to 120 hours, a marked



amount of L-amino acid accumulates in the culture medium. Although the concentration of L-amino acid which accumulates is not limited so long as it is higher than that observed with wild-type strains, and the L-amino acid can be isolated and collected from the medium, it may be 50 g/L or higher, in another example 75 g/L or higher, and in another example 100 g/L or higher.

The L-amino acid can be collected by a known collection method from the culture medium after the culture. For example, by removing cells from the culture medium by centrifugation or the like, and then crystallizing the L-amino acid by concentration, the L-amino acid can be collected.

The culture of the microorganism can be performed as a seed culture and main culture in order to ensure accumulation of the L-amino acid higher than a certain level. The seed culture can be performed as a shaking culture using a flask or the like, or batch culture, and the main culture can be performed as fed-batch culture or continuous culture. Alternatively, both the seed culture and the main culture can be performed as batch culture.

When fed-batch culture or continuous culture is performed, the feed medium can be intermittently fed so that the supply of glycerol and other carbon sources is temporarily stopped. The supply of the feed medium can be stopped for, at maximum, 30% or less, in another example 20% or less, and in another example 10% or less, of the feeding time. When the feed medium is intermittently fed, the feed medium can be initially added over a predetermined time, and the second and following additions can be controlled so that they are started when an elevation of pH or dissolved oxygen concentration is detected by a computer upon depletion of the carbon source in the fermentation medium. This usually occurs during the period when no medium is being fed, and prior to when the medium is fed, and thus the substrate concentration in the culture tank is always automatically maintained at a low level (U.S. Pat. No. 5,912,113).

The feed medium used for the fed-batch culture can be a medium containing glycerol or another carbon source and a nutrient having a growth promoting effect (growth promoting factor), and the glycerol concentration and the other carbon source concentration in the fermentation medium can be controlled to be at predetermined concentrations or lower. As the other carbon source, glucose, sucrose and fructose are examples. As the growth promoting factor, nitrogen source, phosphoric acid, amino acids and so forth are examples. As the nitrogen source, ammonia, ammonium salts such as ammonium sulfate, ammonium carbonate, ammonium chloride, ammonium phosphate, ammonium acetate and urea, nitrates and so forth can be used. Further, as the phosphoric acid source, potassium dihydrogenphosphate and dipotassium hydrogenphosphate can be used. As for the amino acids, when an auxotrophic mutant strain is used, the required nutrients can be added. Further, the feed medium can include one type of medium, or a mixture of two or more types of media. When two or more types of feed media are used, the media may be mixed and fed by using one feed tin or fed by using two or more feed tins.

When the continuous culture method is used, the medium may be extracted and fed simultaneously, or a part of the medium may be extracted, and then the medium may be fed. Further, the method may also be a continuous culture method which includes extracting the culture medium containing the L-amino acid and bacterial cells and returning only the cells to the fermenter to reuse the cells (French Patent No. 2669935). As the method of continuously or intermittently feeding a nutrient source, the same method as used in the fed-batch culture can be used.

The continuous culture method of reusing bacterial cells is a method of intermittently or continuously extracting the fermentation medium when the amino acid concentration reaches a predetermined level, extracting only the L-amino acid and re-circulating filtration residues containing bacterial cells into the fermenter, and it can be performed by referring to, for example, French Patent No. 2669935.

When the culture medium is intermittently extracted, a portion of the amount of L-amino acid can be extracted when the L-amino acid concentration reaches a predetermined level, and fresh medium is fed to continue the culture. Further, as for the volume of the medium to be added, the culture can be performed so that the final volume of the medium after the addition of the medium is equal to the volume of the culture medium before the extraction. The term "equal" can mean that the volume corresponds to about 93 to 107% of the volume of the culture medium before the extraction.

When the culture medium is continuously extracted, the extraction can be started at the same time as or after the feeding of the nutrient medium. For example, the starting time of the extraction is, at maximum, 5 hours, in another example 3 hours, and in another example 1 hour, after the start of the feeding. Further, the extraction volume of the culture medium is preferably equal to the volume of the medium fed.

<3> Microorganisms which can be Used as Parent Strains to Derive Exemplary Microorganisms of the Present Invention

A bacterium belonging to the family Enterobacteriaceae and having an L-amino acid-producing ability, which can metabolize glycerol as a carbon source, can be used as a parent strain, and the desired property can be imparted by the aforementioned methods.

The family Enterobacteriaceae encompasses bacteria belonging to the genera of *Escherichia*, *Enterobacter*, *Erwinia*, *Klebsiella*, *Pantoea*, *Photobacterium*, *Providencia*, *Salmonella*, *Serratia*, *Shigella*, *Morganella*, *Yersinia*, and so forth. In particular, bacteria classified into the family Enterobacteriaceae according to the taxonomy used by the NCBI (National Center for Biotechnology Information) database ([www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=91347](http://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=91347)) are examples.

The expression of "a bacterium belonging to the genus *Escherichia*" can mean that the bacterium is classified into the genus *Escherichia* according to classification known to a person skilled in the art of microbiology, although the bacterium is not particularly limited. Examples of the bacterium belonging to the genus *Escherichia* include, but are not limited to, *Escherichia coli* (*E. coli*).

The bacterium belonging to the genus *Escherichia* is not particularly limited. However, examples include, for example, the bacteria of the phyletic groups described in the work of Bachmann et al., Table 1 (Bachmann, B. J., 1996, pp. 2460-2488, In F. D. Neidhardt (ed.), *Escherichia coli* and *Salmonella*: Cellular and Molecular Biology/Second Edition, American Society for Microbiology Press, Washington, D.C.). Specific examples include the *Escherichia coli* W3110 (ATCC 27325), *Escherichia coli* MG1655 (ATCC 47076) and so forth derived from the prototype wild-type strain, K12 strain.

These strains are available from, for example, American Type Culture Collection (Address: P.O. Box 1549, Manassas, Va. 20108, United States of America). That is, accession numbers are given to each of the strains, and the strains can be ordered by using these numbers. The accession numbers of the strains are listed in the catalogue of the American Type Culture Collection.



The expression "bacterium belonging to the genus *Pantoea*" can mean that the bacterium is classified into the genus *Pantoea* according to classification known to a person skilled in the art of microbiology. Some strains of *Enterobacter agglomerans* have been recently re-classified into *Pantoea agglomerans*, *Pantoea ananatis*, *Pantoea stewartii* or the like based on the nucleotide sequence analysis of 16S rRNA etc. (Int. J. Syst. Bacteriol., 43, 162-173 (1993)). Bacteria belonging to the genus *Pantoea* can encompass such bacteria re-classified into the genus *Pantoea* as described above.

A bacterium having an L-amino acid-producing ability (an ability to produce an L-amino acid) can mean a bacterium which can produce and secrete an L-amino acid in a medium when it is cultured in the medium. It can also mean a bacterium which can accumulate an objective L-amino acid in the medium in an amount not less than 0.5 g/L, and in another example not less than 1.0 g/L. The term "L-amino acid" encompasses L-alanine, L-arginine, L-asparagine, L-aspartic acid, L-cysteine, L-glutamic acid, L-glutamine, glycine, L-histidine, L-isoleucine, L-leucine, L-lysine, L-methionine, L-phenylalanine, L-proline, L-serine, L-threonine, L-tryptophan, L-tyrosine and L-valine.

As a parent strain which can be used, any of the L-amino acid-producing bacteria reported so far can be used, so long as a strain that can assimilate glycerol is chosen. Hereafter, L-amino acid-producing bacteria are described.

#### L-Threonine-Producing Bacteria

Examples of L-threonine-producing bacteria and parent strains which can be used to derive such bacteria include, but are not limited to, strains belonging to the genus *Escherichia*, such as *E. coli* TDH-6/pVIC40 (VKPM B-3996) (U.S. Pat. No. 5,175,107, U.S. Pat. No. 5,705,371), *E. coli* 472T23/pYN7 (ATCC 98081) (U.S. Pat. No. 5,631,157), *E. coli* NRRL-21593 (U.S. Pat. No. 5,939,307), *E. coli* FERM BP-3756 (U.S. Pat. No. 5,474,918), *E. coli* FERM BP-3519 and FERM BP-3520 (U.S. Pat. No. 5,376,538), *E. coli* MG442 (Gusyatiner et al., Genetika (in Russian), 14, 947-956 (1978)), *E. coli* VL643 and VL2055 (EP 1149911 A) and so forth.

The strain TDH-6 is deficient in the thrC gene, as well as being sucrose-assimilative, and the ilvA gene has a leaky mutation. This strain also has a mutation in the rhtA gene, which imparts resistance to high concentration of threonine or homoserine. The B-3996 strain harbors the plasmid pVIC40 obtained by inserting a thrA\*BC operon containing a mutant thrA gene into a RSF1010-derived vector. This mutant thrA gene encodes aspartokinase homoserine dehydrogenase I which is substantially desensitized to feedback inhibition by threonine. The B-3996 strain was deposited on Nov. 19, 1987 at the All-Union Scientific Center of Antibiotics (Nagatinskaya Street 3-A, 117105 Moscow, Russia) under the accession number RIA 1867. The strain was also deposited at the Russian National Collection of Industrial Microorganisms (VKPM) (1 Dorozhny proezd., 1 Moscow 117545, Russia) on Apr. 7, 1987 under the accession number VKPM B-3996.

*E. coli* VKPM B-5318 (EP 0593792 B) can also be used. The B-5318 strain is prototrophic with regard to isoleucine, and in this strain, a temperature-sensitive lambda-phage CI repressor and PR promoter replace the regulatory region of the threonine operon in the plasmid pVIC40. The strain VKPM B-5318 was deposited at the Russian National Collection of Industrial Microorganisms (VKPM) (1 Dorozhny proezd., 1 Moscow 117545, Russia) on May 3, 1990 under the accession number of VKPM B-5318.

The bacterium can be additionally modified so that expression of one or more of the following genes is increased:

the mutant thrA gene which codes for aspartokinase-homoserine dehydrogenase I resistant to feed back inhibition by threonine;  
the thrB gene which codes for homoserine kinase;  
the thrC gene which codes for threonine synthase;  
the rhtA gene which codes for a putative transmembrane protein;  
the asd gene which codes for aspartate- $\beta$ -semialdehyde dehydrogenase; and  
the aspC gene which codes for aspartate aminotransferase (aspartate transaminase).

The thrA gene which encodes aspartokinase-homoserine dehydrogenase I of *Escherichia coli* has been elucidated (nucleotide numbers 337 to 2799, GenBank accession NC\_000913.2, gi: 49175990). The thrA gene is located between the thrL and thrB genes on the chromosome of *E. coli* K-12. The thrB gene which encodes homoserine kinase of *Escherichia coli* has been elucidated (nucleotide numbers 2801 to 3733, GenBank accession NC\_000913.2, gi: 49175990). The thrB gene is located between the thrA and thrC genes on the chromosome of *E. coli* K-12. The thrC gene which encodes threonine synthase of *Escherichia coli* has been elucidated (nucleotide numbers 3734 to 5020, GenBank accession NC\_000913.2, gi: 49175990). The thrC gene is located between the thrB gene and the yaaX open reading frame on the chromosome of *E. coli* K-12. All three of these genes function as a single threonine operon. To increase expression of the threonine operon, the attenuator region which affects the transcription is desirably removed from the operon (WO2005/049808, WO2003/097839).

The mutant thrA gene which codes for aspartokinase-homoserine dehydrogenase I resistant to feed back inhibition by threonine as well as the thrB and thrC genes can be obtained as one operon from the well-known plasmid pVIC40 which is present in the threonine-producing *E. coli* strain VKPM B-3996. The plasmid pVIC40 is described in detail in U.S. Pat. No. 5,705,371.

The rhtA gene is present at 18 min on the *E. coli* chromosome close to the glnHPQ operon, which encodes components of the glutamine transport system. The rhtA gene is identical to ORF1 (ybiF gene, nucleotide numbers 764 to 1651, GenBank accession number AAA218541, gi:440181) and is located between the pexB and ompX genes. The unit expressing a protein encoded by the ORF1 has been designated rhtA gene (rht: resistance to homoserine and threonine). It has also been revealed that the rhtA23 mutation is an A-for-G substitution at position -1 with respect to the ATG start codon (ABSTRACTS of the 17th International Congress of Biochemistry and Molecular Biology in conjugation with Annual Meeting of the American Society for Biochemistry and Molecular Biology, San Francisco, Calif. Aug. 24-29, 1997, abstract No. 457, EP 1013765 A).

The asd gene of *E. coli* has already been elucidated (nucleotide numbers 3572511 to 3571408, GenBank Accession NC\_000913.1, gi:16131307), and can be obtained by PCR (refer to White, T. J., Arnheim, N., and Erlich, H. A., Trends Genet., 5, 185-189 (1989)) utilizing primers prepared based on the nucleotide sequence of the gene. The asd genes of other microorganisms can be obtained in a similar manner.

The aspC gene of *E. coli* has also already been elucidated (nucleotide numbers 983742 to 984932, GenBank Accession NC\_000913.1, gi:16128895), and can be obtained by PCR. The aspC genes of other microorganisms can be obtained in a similar manner.

#### L-Lysine-Producing Bacteria

Examples of L-lysine-producing bacteria belonging to the genus *Escherichia* include mutants having resistance to an



L-lysine analogue. L-Lysine analogues inhibit growth of bacteria belonging to the genus *Escherichia*, but this inhibition is fully or partially desensitized when L-lysine is present in a medium. Examples of the L-lysine analogue include, but are not limited to, oxalysine, lysine hydroxamate, S-(2-aminoethyl)-L-cysteine (AEC),  $\gamma$ -methyllysine,  $\alpha$ -chlorocaprolactam and so forth. Mutants having resistance to these lysine analogues can be obtained by subjecting bacteria belonging to the genus *Escherichia* to a conventional artificial mutagenesis treatment. Specific examples of bacterial strains useful for producing L-lysine include *Escherichia coli* AJ11442 (FERM BP-1543, NRRL B-12185; see U.S. Pat. No. 4,346,170) and *Escherichia coli* VL611. In these microorganisms, feedback inhibition of aspartokinase by L-lysine is desensitized.

The WC196 strain can be used as an L-lysine-producing bacterium of *Escherichia coli*. This bacterial strain was bred by conferring AEC resistance to the W3110 strain, which was derived from *Escherichia coli* K-12. This strain was designated *Escherichia coli* AJ13069 and was deposited at the National Institute of Bioscience and Human-Technology, Agency of Industrial Science and Technology (currently National Institute of Advanced Industrial Science and Technology, International Patent Organism Depository, Central 6, 1-1, Higashi 1-Chome, Tsukuba-shi, Ibaraki-ken, 305-8566, Japan) on Dec. 6, 1994 and assigned an accession number of FERM P-14690. Then, it was converted to an international deposit under the provisions of the Budapest Treaty on Sep. 29, 1995, and assigned an accession number of FERM BP-5252 (U.S. Pat. No. 5,827,698).

Examples of L-lysine-producing bacteria and parent strains which can be used to derive such bacteria also include strains in which expression of one or more genes encoding an L-lysine biosynthetic enzyme can be increased. Examples of such genes include, but are not limited to, dihydrodipicolinate synthase gene (*dapA*), aspartokinase gene (*lysC*), dihydrodipicolinate reductase gene (*dapB*), diaminopimelate decarboxylase gene (*lysA*), diaminopimelate dehydrogenase gene (*ddh*) (U.S. Pat. No. 6,040,160), phosphoenolpyruvate carboxylase gene (*ppc*), aspartate semialdehyde dehydrogenase gene (*asd*), and aspartase gene (*aspA*) (EP 1253195 A). In addition, the parent strains can have an increased level of expression of the gene involved in energy efficiency (*cyo*) (EP 1170376 A), the gene encoding nicotinamide nucleotide transhydrogenase (*pntAB*) (U.S. Pat. No. 5,830,716), the *ybjE* gene (WO2005/073390), the gene coding for glutamate dehydrogenase (*gdhA*, Gene, 23:199-209 (1983)), or combinations thereof. Abbreviations of the genes are indicated in the parentheses.

It is known that wild-type dihydrodipicolinate synthetase derived from *Escherichia coli* suffers from feedback inhibition by L-lysine, while wild-type aspartokinase from *Escherichia coli* suffers from suppression and feedback inhibition by L-lysine. Therefore, when the *dapA* and *lysC* genes are used, these genes are preferably mutant genes coding the enzymes that do not suffer from the feedback inhibition by L-lysine.

Examples of DNA encoding a mutant dihydrodipicolinate synthetase desensitized to feedback inhibition by L-lysine include a DNA encoding a protein which has the amino acid sequence of the enzyme in which the histidine at position 118 is replaced by tyrosine. Examples of DNA encoding a mutant aspartokinase desensitized to feedback inhibition by L-lysine include a DNA encoding an AKIII having the amino acid sequence in which the threonine at position 352, the glycine at position 323, and the methionine at position 318 are replaced by isoleucine, asparagine and isoleucine, respectively (U.S.

Pat. No. 5,661,012 and U.S. Pat. No. 6,040,160). Such mutant DNAs can be obtained by site-specific mutagenesis using PCR or the like.

Wide host-range plasmids RSFD80, pCAB1, and pCABD2 are known as plasmids containing a mutant *dapA* gene encoding a mutant dihydrodipicolinate synthetase and a mutant *lysC* gene encoding a mutant aspartokinase (U.S. Pat. No. 6,040,160). *Escherichia coli* JM109 strain transformed with RSFD80 was named AJ12396 (U.S. Pat. No. 6,040,160), and the strain was deposited at the National Institute of Bioscience and Human-Technology, Agency of Industrial Science and Technology, Ministry of International Trade and Industry (currently, International Patent Organism Depository, National Institute of Advanced Industrial Science and Technology Central 6, 1-1, Higashi 1-Chome, Tsukuba-shi, Ibaraki-ken, 305-8566, Japan) on Oct. 28, 1993 and assigned an accession number of FERM P-13936, and the deposit was then converted to an international deposit under the provisions of Budapest Treaty on Nov. 1, 1994 and assigned an accession number of FERM BP-4859. RSFD80 can be obtained from the AJ12396 strain by a known method.

Examples of L-lysine-producing bacteria and parent strains which can be used to derive such bacteria also include strains having decreased or eliminated activity of an enzyme that catalyzes a reaction for generating a compound other than L-lysine by branching off from the biosynthetic pathway of L-lysine. Examples of the enzymes that catalyze a reaction for generating a compound other than L-lysine by branching off from the biosynthetic pathway of L-lysine include homoserine dehydrogenase, lysine decarboxylase (U.S. Pat. No. 5,827,698), and the malic enzyme (WO2005/010175). In order to reduce or delete the lysine decarboxylase activity, it is preferable to reduce expression of both the *cadA* gene and *ldcC* gene coding for lysine decarboxylase (International Publication WO2006/038695).

#### L-Cysteine-Producing Bacteria

Examples of L-cysteine-producing bacteria and parent strains which can be used to derive such bacteria include, but are not limited to, strains belonging to the genus *Escherichia*, such as *E. coli* JM15 which is transformed with different *cysE* alleles coding for feedback-resistant serine acetyltransferases (U.S. Pat. No. 6,218,168, Russian Patent Application No. 2003121601); *E. coli* W3110 having over-expressed genes which encode proteins suitable for secreting substances toxic for cells (U.S. Pat. No. 5,972,663); *E. coli* strains having lowered cysteine desulfohydrase activity (Japanese Patent Laid-open No. 11-155571); and *E. coli* W3110 with increased activity of a positive transcriptional regulator for cysteine regulon encoded by the *cysB* gene (WO01/27307).

#### L-Leucine-Producing Bacteria

Examples of L-leucine-producing bacteria and parent strains which can be used to derive such bacteria include, but are not limited to, strains belonging to the genus *Escherichia*, such as *E. coli* strains resistant to leucine (for example, the strain 57 (VKPM B-7386, U.S. Pat. No. 6,124,121)) or leucine analogues including  $\beta$ -2-thienylalanine, 3-hydroxyleucine, 4-azaleucine and 5,5,5-trifluoroleucine (Japanese Patent Publication (Kokoku) No. 62-34397 and Japanese Patent Laid-open No. 8-70879); *E. coli* strains obtained by a gene engineering method described in WO96/06926; and *E. coli* H-9068 (Japanese Patent Laid-open No. 8-70879).

The bacterium can be improved by enhancing expression of one or more genes involved in L-leucine biosynthesis. Examples of such genes include genes of the *leuABCD* operon, of which typical example is a mutant *leuA* gene coding for isopropyl malate synthase desensitized to feedback inhibition by L-leucine (U.S. Pat. No. 6,403,342). In



addition, the bacterium can be improved by increasing expression of one or more genes coding for proteins which excrete L-amino acid from bacterial cells. Examples of such genes include the b2682 and b2683 genes (*ygaZH* genes) (EP 1239041 A2).

#### L-Histidine-Producing Bacteria

Examples of L-histidine-producing bacteria and parent strains which can be used to derive such bacteria include, but are not limited to, strains belonging to the genus *Escherichia*, such as *E. coli* strain 24 (VKPM B-5945, RU 2003677); *E. coli* strain 80 (VKPM B-7270, RU 2119536); *E. coli* NRRL B-12116 to B12121 (U.S. Pat. No. 4,388,405); *E. coli* H-9342 (FERM BP-6675) and H-9343 (FERM BP-6676) (U.S. Pat. No. 6,344,347); *E. coli* H-9341 (FERM BP-6674) (EP 1085087); and *E. coli* A180/pFM201 (U.S. Pat. No. 6,258,554).

Examples of L-histidine-producing bacteria and parent strains which can be used to derive such bacteria also include strains in which expression of one or more genes encoding an L-histidine biosynthetic enzyme can be increased. Examples of such genes include ATP phosphoribosyl transferase gene (*hisG*), phosphoribosyl AMP cyclohydrolase gene (*hisI*), phosphoribosyl-ATP pyrophosphohydrolase gene (*hisI*), phosphoribosylformimino-5-aminoimidazole carboxamide ribotide isomerase gene (*hisA*), amidotransferase gene (*hisH*), histidinol phosphate aminotransferase gene (*hisC*), histidinol phosphatase gene (*hisB*), histidinol dehydrogenase gene (*hisD*), and so forth.

It is known that the L-histidine biosynthetic enzymes encoded by *hisG* and *hisBHAFI* are inhibited by L-histidine, and therefore L-histidine-producing ability can also be efficiently enhanced by introducing a mutation which confers resistance to the feedback inhibition into the ATP phosphoribosyl transferase gene (*hisG*) (Russian Patent Nos. 2003677 and 2119536).

Specific examples of strains having L-histidine-producing ability include *E. coli* FERM-P 5038 and 5048 which are introduced with a vector carrying a DNA encoding an L-histidine biosynthetic enzyme (Japanese Patent Laid-open No. 56-005099), *E. coli* strains introduced with a gene for amino acid-export (EP 1016710 A), *E. coli* 80 strain imparted with sulfaguanidine, DL-1,2,4-triazole-3-alanine, and streptomycin resistance (VKPM B-7270, Russian Patent No. 2119536), and so forth.

#### L-Glutamic Acid-Producing Bacteria

Examples of L-glutamic acid-producing bacteria and parent strains which can be used to derive such bacteria include, but are not limited to, strains belonging to the genus *Escherichia*, such as *E. coli* VL334*thrC*<sup>+</sup> (EP 1172433). *E. coli* VL334 (VKPM B-1641) is an L-isoleucine and L-threonine auxotrophic strain having mutations in *thrC* and *ilvA* genes (U.S. Pat. No. 4,278,765). A wild-type allele of the *thrC* gene was transferred by the method of general transduction using a bacteriophage P1 grown on the wild-type *E. coli* K12 strain (VKPM B-7) cells. As a result, an L-isoleucine auxotrophic L-glutamic acid-producing strain VL334*thrC*<sup>+</sup> (VKPM B-8961) was obtained.

Examples of L-glutamic acid-producing bacteria and parent strains which can be used to derive such bacteria include, but are not limited to, strains in which expression of one or more genes encoding an L-glutamic acid biosynthetic enzyme can be increased. Examples of such genes include genes encoding glutamate dehydrogenase (*gdhA*), glutamine synthetase (*glnA*), glutamate synthetase (*gltAB*), isocitrate dehydrogenase (*icdA*), aconitate hydratase (*acnA*, *acnB*), citrate synthase (*gltA*), phosphoenolpyruvate carboxylase (*ppc*), pyruvate dehydrogenase (*aceEF*, *lpdA*), pyruvate

kinase (*pykA*, *pykF*), phosphoenolpyruvate synthase (*ppsA*), enolase (*eno*), phosphoglyceromutase (*pgmA*, *pgmI*), phosphoglycerate kinase (*pgk*), glyceraldehyde-3-phosphate dehydrogenase (*gapA*), triose phosphate isomerase (*tpiA*), fructose bisphosphate aldolase (*fbp*), phosphofructokinase (*pfkA*, *pfkB*), glucose phosphate isomerase (*pgi*), and so forth.

Examples of strains modified to increase expression of the citrate synthetase gene, the phosphoenolpyruvate carboxylase gene, and/or the glutamate dehydrogenase gene include those disclosed in EP 1078989 A, EP 955368 A and EP 952221 A.

Examples of L-glutamic acid-producing bacteria and parent strains which can be used to derive such bacteria also include strains having decreased or eliminated activity of an enzyme that catalyzes synthesis of a compound other than L-glutamic acid by branching off from an L-glutamic acid biosynthesis pathway. Examples of such enzymes include isocitrate lyase (*aceA*),  $\alpha$ -ketoglutarate dehydrogenase (*sucA*), phosphotransacetylase (*pta*), acetate kinase (*ack*), acetohydroxy acid synthase (*ilvG*), acetolactate synthase (*ilvI*), formate acetyltransferase (*pfl*), lactate dehydrogenase (*ldh*), glutamate decarboxylase (*gadAB*), and so forth. Bacteria belonging to the genus *Escherichia* deficient in  $\alpha$ -ketoglutarate dehydrogenase activity or having reduced  $\alpha$ -ketoglutarate dehydrogenase activity and methods for obtaining them are described in U.S. Pat. Nos. 5,378,616 and 5,573,945.

Specific examples of such strains include the following:

- E. coli* W3110*sucA::Km*<sup>r</sup>
- E. coli* AJ12624 (FERM BP-3853)
- E. coli* AJ12628 (FERM BP-3854)
- E. coli* AJ12949 (FERM BP-4881)

*E. coli* W3110*sucA::Km*<sup>r</sup> is a strain obtained by disrupting the  $\alpha$ -ketoglutarate dehydrogenase gene (hereinafter also referred to as "sucA gene") of *E. coli* W3110. This strain is completely deficient in  $\alpha$ -ketoglutarate dehydrogenase.

Other examples of L-glutamic acid-producing bacteria include those which belong to the genus *Escherichia* and have resistance to an aspartic acid antimetabolite. These strains may also be deficient in  $\alpha$ -ketoglutarate dehydrogenase, and examples include, for example, *E. coli* AJ13199 (FERM BP-5807) (U.S. Pat. No. 5,908,768), FFRM P-12379 which additionally has a lowered L-glutamic acid decomposing ability (U.S. Pat. No. 5,393,671); AJ13138 (FERM BP-5565) (U.S. Pat. No. 6,110,714), and so forth.

Examples of L-glutamic acid-producing bacteria include mutant strains belonging to the genus *Pantoea* which are deficient in  $\alpha$ -ketoglutarate dehydrogenase activity or have a decreased  $\alpha$ -ketoglutarate dehydrogenase activity, and they can be obtained as described above. Such strains include *Pantoea ananatis* AJ13356 (U.S. Pat. No. 6,331,419). *Pantoea ananatis* AJ13356 was deposited at the National Institute of Bioscience and Human-Technology, Agency of Industrial Science and Technology (currently, National Institute of Advanced Industrial Science and Technology, International Patent Organism Depository, Central 6, 1-1, Higashi 1-Chome, Tsukuba-shi, Ibaraki-ken, 305-8566, Japan) on Feb. 19, 1998 under an accession number of FERM P-16645. It was then converted to an international deposit under the provisions of Budapest Treaty on Jan. 11, 1999 and assigned an accession number of FERM BP-6616. *Pantoea ananatis* AJ13356 is deficient in  $\alpha$ -ketoglutarate dehydrogenase activity as a result of disruption of the  $\alpha$ KGDH-E1 subunit gene (*sucA*). This strain was identified as *Enterobacter agglomerans* when it was isolated and deposited as the *Enterobacter agglomerans* AJ13356. However, it was recently re-classified



as *Pantoea ananatis* on the basis of nucleotide sequencing of 16S rRNA and so forth. Although AJ13356 was deposited at the aforementioned depository as *Enterobacter agglomerans*, it is described as *Pantoea ananatis* in this specification.

#### L-Phenylalanine-Producing Bacteria

Examples of L-phenylalanine-producing bacteria and parent strains which can be used to derive such bacteria include, but are not limited to, strains belonging to the genus *Escherichia*, such as *E. coli* AJ12739 (tyrA::Tn10, tyrR) (VKPM B-8197); *E. coli* HW1089 (ATCC 55371) harboring the mutant pheA34 gene (U.S. Pat. No. 5,354,672); *E. coli* MWEC101-b (KR 8903681); *E. coli* NRRL B-12141, NRRL B-12145, NRRL B-12146 and NRRL B-12147 (U.S. Pat. No. 4,407,952). As parent strains, *E. coli* K-12 [W3110 (tyrA)/pPHAB] (FERM BP-3566), *E. coli* K-12 [W3110 (tyrA)/pPHAD] (FERM BP-12659), *E. coli* K-12 [W3110 (tyrA)/pPHATerm] (FERM BP-12662) and *E. coli* K-12 [W3110 (tyrA)/pBR-aroG4, pACMAB] named as AJ12604 (FERM BP-3579) may also be used (EP 488424 B1). Furthermore, L-phenylalanine-producing bacteria belonging to the genus *Escherichia* with an enhanced activity of the protein encoded by the yedA gene or the yddG gene can also be used (U.S. Patent Published Application Nos. 2003/0148473 A1 and 2003/0157667 A1).

#### L-Tryptophan-Producing Bacteria

Examples of tryptophan-producing bacteria and parent strains which can be used to derive such bacteria, but are not limited to, strains belonging to the genus *Escherichia*, such as *E. coli* JP4735/pMU3028 (DSM10122) and JP6015/pMU91 (DSM10123) which are deficient in the tryptophanyl-tRNA synthetase encoded by mutant trpS gene (U.S. Pat. No. 5,756,345); *E. coli* SV164 (pGH5) having a serA allele encoding phosphoglycerate dehydrogenase free from feedback inhibition by serine and a trpE allele encoding anthranilate synthase free from feedback inhibition by tryptophan (U.S. Pat. No. 6,180,373); *E. coli* AGX17(pGX44) (NRRL B-12263) and AGX6(pGX50)aroP (NRRL B-12264) deficient in tryptophanase (U.S. Pat. No. 4,371,614); and *E. coli* AGX17/pGX50, pACKG4-pps in which phosphoenolpyruvate-producing ability is enhanced (WO97/08333, U.S. Pat. No. 6,319,696). L-Tryptophan-producing bacteria belonging to the genus *Escherichia* with an enhanced activity of the protein encoded by the yedA gene or the yddG gene may also be used (U.S. Patent Published Application Nos. 2003/0148473 A1 and 2003/0157667 A1).

Examples of L-tryptophan-producing bacteria and parent strains which can be used to derive such bacteria also include strains in which one or more activities of the enzymes anthranilate synthase (trpE), phosphoglycerate dehydrogenase (serA), and tryptophan synthase (trpAB) are increased. The anthranilate synthase and phosphoglycerate dehydrogenase both suffer from feedback inhibition by L-tryptophan and L-serine, and therefore a mutation desensitizing them to the feedback inhibition may be introduced into these enzymes. Specific examples of strains having such a mutation include *E. coli* SV164 which harbors desensitized anthranilate synthase and a transformant strain obtained by introducing the plasmid pGH5 (WO94/08031), which contains a mutant serA gene encoding feedback inhibition-desensitized phosphoglycerate dehydrogenase, into the *E. coli* SV164.

Examples of L-tryptophan-producing bacteria and parent strains which can be used to derive such bacteria also include strains into which the tryptophan operon containing a gene encoding inhibition-desensitized anthranilate synthase is introduced (Japanese Patent Laid-open Nos. 57-71397, 62-244382, U.S. Pat. No. 4,371,614). Moreover, L-tryptophan-producing ability may be imparted by increasing

expression of a gene which encodes tryptophan synthase in the tryptophan operon (trpBA). The tryptophan synthase consists of  $\alpha$  and  $\beta$  subunits which are encoded by the trpA and trpB genes, respectively. In addition, L-tryptophan-producing ability can also be improved by increasing expression of the isocitrate lyase-malate synthase operon (WO2005/103275).

#### L-Proline-Producing Bacteria

Examples of L-proline-producing bacteria and parent strains which can be used to derive such bacteria include, but are not limited to, strains belonging to the genus *Escherichia*, such as *E. coli* 702ilvA (VKPM B-8012) which is deficient in the ilvA gene and is able to produce L-proline (EP 1172433).

The bacterium can be improved by increasing expression of one or more genes involved in L-proline biosynthesis. Examples of such genes include the proB gene coding for glutamate kinase desensitized to feedback inhibition by L-proline (DE 3127361). In addition, the bacterium can be improved by increasing expression of one or more genes coding for proteins excreting L-amino acid from bacterial cells. Examples of such genes include the b2682 and b2683 genes (ygaZH genes) (EP 1239041 A2).

Examples of bacteria belonging to the genus *Escherichia* and having L-proline-producing ability include the following *E. coli* strains: NRRL B-12403 and NRRL B-12404 (British Patent No. 2075056), VKPM B-8012 (Russian Patent Application No. 2000124295), plasmid mutants described in German Patent No. 3127361, plasmid mutants described by Bloom F. R. et al. (The 15th Miami winter symposium, 1983, p. 34), and so forth.

#### L-Arginine-Producing Bacteria

Examples of L-arginine-producing bacteria and parent strains which can be used to derive such bacteria include, but are not limited to, strains belonging to the genus *Escherichia*, such as *E. coli* strain 237 (VKPM B-7925) (U.S. Patent Published Application 2002/058315A1) and its derivative strains harboring mutant N-acetylglutamate synthase (Russian Patent Application No. 2001112869), *E. coli* strain 382 (VKPM B-7926) (EP 1170358 A1), and an arginine-producing strain into which argA gene encoding N-acetylglutamate synthetase is introduced (EP 1170361 A1).

Examples of L-arginine-producing bacteria and parent strains which can be used to derive such bacteria also include strains in which expression of one or more genes encoding an L-arginine biosynthetic enzyme can be increased. Examples of such genes include N-acetylglutamyl phosphate reductase gene (argC), ornithine acetyl transferase gene (argJ), N-acetylglutamate kinase gene (argB), acetylornithine transaminase gene (argD), ornithine carbamoyl transferase gene (argF), argininosuccinic acid synthetase gene (argG), argininosuccinic acid lyase gene (argH), and carbamoyl phosphate synthetase gene (carAB).

#### L-Valine-Producing Bacteria

Example of L-valine-producing bacteria and parent strains which can be used to derive such bacteria include, but are not limited to, strains which have been modified to overexpress the ilvGMEDA operon (U.S. Pat. No. 5,998,178). It is desirable to remove the region of the ilvGMEDA operon which is required for attenuation so that expression of the operon is not attenuated by produced L-valine. Further, the ilvA gene in the operon is desirably disrupted so that threonine deaminase activity is decreased.

Examples of L-valine-producing bacteria and parent strains which can be used to derive such bacteria also include mutants having a mutation of amino-acyl t-RNA synthetase (U.S. Pat. No. 5,658,766). For example, *E. coli* VL1970, which has a mutation in the ileS gene encoding isoleucine



tRNA synthetase, can be used. *E. coli* VL1970 was deposited at the Russian National Collection of Industrial Microorganisms (VKPM) (1 Dorozhny Proezd, 1 Moscow 117545, Russia) on Jun. 24, 1988 under the accession number of VKPM B-4411.

Furthermore, mutants requiring lipoic acid for growth and/or lacking H<sup>+</sup>-ATPase (WO96/06926) can also be used as the parent strains.

#### L-Isoleucine-Producing Bacteria

Examples of L-isoleucine-producing bacteria and parent strains include, but are not limited to, mutants having resistance to 6-dimethylaminopurine (Japanese Patent Laid-open No. 5-304969 A), mutants having resistance to an isoleucine analogue such as thiaisoleucine and isoleucine hydroxamate, and such mutants further having resistance to DL-ethionine and/or arginine hydroxamate (Japanese Patent Laid-open No. 5-130882). In addition, recombinant strains transformed with genes encoding proteins involved in L-isoleucine biosynthesis, such as threonine deaminase and acetohydroxate synthase, can also be used as the parent strains (Japanese Patent Laid-open No. 2-458, FR 0356739, and U.S. Pat. No. 5,998, 178).

### EXAMPLES

#### Example 1

##### Construction of L-Lysine-Producing Bacterium with Enhanced Fructose-6-Phosphate Aldolase, Glycerol Dehydrogenase and Dihydroxyacetone Kinase Activities

###### <1-1> Construction of Plasmid for dak1 Gene Expression

The total nucleotide sequence of *Saccharomyces cerevisiae* chromosome has already been elucidated (Science, 25 (1996)). On the basis of the nucleotide sequence of the dak1 gene reported in this literature, the synthetic oligonucleotide of SEQ ID NO: 14 was prepared as a 5' primer, and the synthetic oligonucleotide of SEQ ID NO: 15 was prepared as a 3' primer. PCR was performed by using these synthetic oligonucleotides and the chromosomal DNA of the *Saccharomyces cerevisiae* JCM7255 strain as a template. The PCR product was purified and ligated with the vector pMW119 (Takara Bio) digested with HindIII and Sall to construct a dak1 expression plasmid pMW-dak1. The JCM7255 strain is stored in the independent administrative agency, RIKEN, "Japan Collection of Microorganisms", 2-1, Hirosawa, Wako-shi, Saitama-ken.

###### <1-2> Construction of Glycerol Dehydrogenase Activity-Improved Strain

A WC196ΔcadAΔldcC strain modified to have the structure shown in SEQ ID NO: 11 was constructed. For the construction of the strain having this structure, the sequence of SEQ ID NO: 9 (PCR product) was used. In the sequence of SEQ ID NO: 9, the sequence of the nucleotide numbers 1 to 172 is the attR sequence of λ phage, the sequence of the nucleotide numbers 324 to 983 is a chloramphenicol resistance gene (cat), the sequence of the nucleotide numbers 1540 to 1653 is the attL sequence of λ phage, and the sequence of the nucleotide numbers 1654 to 1733 is the tacM promoter.

The tacM promoter (SEQ ID NO: 10) can be constructed by replacing the TTGACA sequence of the tac promoter (Gene, 25 (2-3), 167-178 (1983)) at the -35 region with TTCACA. The sequence of SEQ ID NO: 9 can be constructed by referring to the construction of pMW118-attL-Cm-attR (WO2005/010175).

The sequence of SEQ ID NO: 9 as a template was amplified by PCR using the primers of SEQ ID NOS: 12 and 13, and this amplification product was inserted into chromosome of the WC196ΔcadAΔldcC strain (refer to International Publication WO2006/038695) by the λ-RED method (WO2005/010175) to construct a strain in which the promoter sequence upstream of the gldA was replaced. In this way, a strain with improved glycerol dehydrogenase activity, WC196ΔcadAΔldcCPTacMgldA::Cm strain, was obtained.

###### <1-3> Construction of L-Lysine-Producing Bacterium with Enhanced Fructose-6-Phosphate Aldolase and Glycerol Dehydrogenase Activities

A WC196ΔcadAΔldcC strain modified to have the structure shown in SEQ ID NO: 92 was constructed. For construction of the strain having this structure, the sequence of SEQ ID NO: 9 (PCR product) was used. In the sequence of SEQ ID NO: 9, the sequence of the nucleotide numbers 1 to 172 is the attR sequence of λ phage, the sequence of the nucleotide numbers 324 to 983 is a chloramphenicol resistance gene (cat), the sequence of the nucleotide numbers 1540 to 1653 is the attL sequence of λ phage, and the sequence of the nucleotide numbers 1654 to 1733 is the tacM promoter.

The tacM promoter (SEQ ID NO: 10) can be constructed by replacing the TTGACA sequence of the tac promoter (Gene, 25 (2-3), 167-178 (1983)) at the -35 region with TTCACA. The sequence of SEQ ID NO: 9 can be constructed by referring to the construction of pMW118-attL-Cm-attR (WO2005/010175).

The sequence of SEQ ID NO: 9 as a template was amplified by PCR using the primers of SEQ ID NOS: 93 and 94, and this amplification product was inserted into chromosome of the WC196ΔcadAΔldcC strain (refer to International Publication WO2006/038695) by the λ-RED method (WO2005/010175) to construct a strain in which the promoter sequence upstream of the fsaB-gldA operon was replaced. In this way, a strain with improved fructose-6-phosphate aldolase and glycerol dehydrogenase activities, WC196ΔcadAΔldcCPTacM fsaB-gldA::Cm strain, was obtained.

###### <1-4> Construction of L-Lysine-Producing Bacteria with Enhanced Fructose-6-Phosphate Aldolase, Glycerol Dehydrogenase and Dihydroxyacetone Kinase Activities

The WC196ΔcadAΔldcC strain (refer to International Publication WO2006/038695), the WC196ΔcadAΔldcCPTacMgldA::Cm strain and the WC196ΔcadAΔldcCPTacM fsaB-gldA::Cm strain were transformed with the plasmid pCABD2 for Lys production carrying dapA, dapB and lysC genes (International Publication WO01/53459) in a conventional manner to obtain WC196ΔcadAΔldcC/pCABD2 strain, WC196ΔcadAΔldcCPTacMgldA::Cm/pCABD2 strain, and WC196ΔcadAΔldcCPTacM fsaB-gldA::Cm/pCABD2 strain. Furthermore, the WC196ΔcadAΔldcC/pCABD2 strain, the WC196ΔcadAΔldcCPTacMgldA::Cm/pCABD2 strain and the WC196ΔcadAΔldcCPTacM fsaB-gldA::Cm/pCABD2 strain were transformed with the dak1 expression plasmid pMW-dak1 in a conventional manner to obtain WC196ΔcadAΔldcC/pCABD2,pMW-dak1 strain, WC196ΔcadAΔldcCPTacMgldA::Cm/pCABD2,pMW-dak1 strain and WC196ΔcadAΔldcCPTacM fsaB-gldA::Cm/pCABD2,pMW-dak1 strain.

These strains were each cultured in L medium containing 20 mg/L of streptomycin or 20 mg/L of streptomycin and 50 mg/L of ampicillin at 37° C. until the final OD600 became about 0.6, then a 40% glycerol solution in a volume equal to the culture medium was added to each culture medium, and the mixture was stirred, then divided into appropriate volumes, and stored at -80° C. These are called glycerol stocks.



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## Example 2

Evaluation of L-Lysine-Producing Bacteria with Enhanced Fructose-6-Phosphate Aldolase, Glycerol Dehydrogenase and Dihydroxyacetone Kinase Activities

The aforementioned glycerol stocks of the strains were thawed, 100  $\mu$ L of each stock was uniformly applied to an L plate containing 20 mg/L of streptomycin or 20 mg/L of streptomycin and 50 mg/L of ampicillin, and culture was performed at 37° C. for 24 hours. The obtained cells on the plate were suspended in 1 ml of physiological saline, the suspension was inoculated in a volume V obtained by dividing a constant 50 with absorbance at 600 nm (n) of the suspension diluted 101 times ( $V=50/n$ ) into 20 mL of a fermentation medium containing 20 mg/L of streptomycin or 20 mg/L of streptomycin and 50 mg/L of ampicillin contained in a 500-mL Sakaguchi flask, and culture was performed at 37° C. for 48 hours on a reciprocally shaking culture machine. After the culture, amount of lysine accumulated in the medium was measured by a known method (Biotec Analyzer AS210, SAKURA SEIKI).

The composition of the fermentation medium is shown below (unit: g/L).

Glycerol	40
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	24
K <sub>2</sub> HPO <sub>4</sub>	1.0
MgSO <sub>4</sub> •7H <sub>2</sub> O	1.0
FeSO <sub>4</sub> •7H <sub>2</sub> O	0.01
MnSO <sub>4</sub> •5H <sub>2</sub> O	0.01
Yeast extract	2.0
To final volume of 1 L	

The medium was adjusted to pH 7.0 with KOH, and autoclaved at 115° C. for 10 minutes, provided that glycerol and MgSO<sub>4</sub>•7H<sub>2</sub>O were separately sterilized, and 30 g/L of CaCO<sub>3</sub> of Japanese Pharmacopoeia subjected to hot air sterilization at 180° C. for 2 hours was added.

As antibiotics, 20 mg/L of streptomycin or 20 mg/L of streptomycin and 50 mg/L of ampicillin were added. The culture was performed under the conditions of a temperature of 37° C. and stirring at 115 rpm for 48 hours.

The results are shown in Table 5 (OD means absorbance at 600 nm representing cell amount, Lys (g/L) means the amount of L-lysine accumulated in flask, and yield (%) means yield of L-lysine based on the substrate). Whereas the strain in which only glycerol dehydrogenase was enhanced, the strain in which only dihydroxyacetone kinase was enhanced, and the strain in which fructose-6-phosphate aldolase and glycerol dehydrogenase were enhanced did not show change of yield and productivity compared with the non-modified strain, the WC196 $\Delta$ cadA $\Delta$ ldcCPtacMgldA::Cm/pCABD2, pMW-dak1 strain in which both glycerol dehydrogenase and dihydroxyacetone kinase using ATP as a phosphate donor were enhanced accumulated a larger amount of L-lysine compared with the other strains. Further, the WC196 $\Delta$ cadA $\Delta$ ldcCPtacM fsaB-gldA::Cm/pCABD2, pMW-dak1 strain in which fructose-6-phosphate aldolase, glycerol dehydrogenase and dihydroxyacetone kinase using ATP as a phosphate donor were enhanced accumulated a further larger amount of L-lysine.

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TABLE 5

Table 5: L-Lysine accumulation of strains with enhanced fructose-6-phosphate aldolase (fsaB), glycerol dehydrogenase (gldA) and dihydroxyacetone kinase (dak1) activities

			OD	Lys (g/L)	Yield (%)	
5	WC196LC	pCABD2	—	16.7	14.7	36.8
	WC196LC	pCABD2	pMW-dak1	14.3	14.8	36.9
10	WC196LCPtacMgldA	pCABD2	—	18.1	14.7	36.8
	WC196LCPtacMfsaB-gldA	pCABD2	—	18.5	14.3	35.8
	WC196LCPtacMgldA	pCABD2	pMW-dak1	15.3	15.3	38.1
15	WC196LCPtacMfsaB-gldA	pCABD2	pMW-dak1	14.0	16.9	42.1

In the names of strains mentioned in the table, "LC" is an abbreviation of "AcadA $\Delta$ ldcC", and "Cm" is omitted.

## Example 3

Construction of L-Threonine-Producing Bacteria with Enhanced Glycerol Dehydrogenase and Dihydroxyacetone Kinase Activities

<3-1> Construction of Glycerol Dehydrogenase Activity-Improved Strain

B5318 strains modified to have the structures shown in SEQ ID NOS: 90 and 91 were constructed. For construction of the strains having these structures, sequences of SEQ ID NOS: 88 and 89 (PCR products) were used. In the sequences of SEQ ID NOS: 88 and 89, the sequences of the nucleotide numbers 1 to 72 are the attR sequences of  $\lambda$  phage, the sequences of the nucleotide numbers 324 to 983 are chloramphenicol resistance genes (cat), the sequences of the nucleotide numbers 1540 to 1653 are the attL sequences of  $\lambda$  phage, and the sequences of the nucleotide numbers 1654 to 1733 are the tacM2 and tacM3 promoters.

The tacM2 and tacM3 promoters are constitutive promoters which can be constructed by replacing the TTGACA sequence of the tac promoter (Gene, 25 (2-3), 167-178 (1983)) at the -35 region with TGTACA and TTGGCA (Molecular Biology 39 (5) 719-726 (2005)). The sequences of SEQ ID NOS: 88 and 89 can be constructed by referring to the construction of pMW118-attL-Cm-attR (WO2005/010175).

The sequences of SEQ ID NOS: 88 and 89 as templates were amplified by PCR using the primers of SEQ ID NOS: 12 and 13, and these amplification products were each inserted into chromosome of the B5318 strain (VKPM B-5318) by the  $\lambda$ -RED method (WO2005/010175) to obtain strains in which the promoter sequence upstream of the gldA was replaced. In this way, strains with improved glycerol dehydrogenase activity, B5318PtacM2gldA::Cm strain and B5318PtacM3gldA::Cm strain, were obtained.

<1-3> Construction of L-Threonine-Producing Bacteria with Enhanced Glycerol Dehydrogenase and Dihydroxyacetone Kinase Activities

The B5318PtacM2gldA::Cm strain and the B5318PtacM3gldA::Cm strain were transformed with the dak1 expression plasmid pMW-dak1 in a conventional manner to obtain B5318PtacM2gldA::Cm/pMW-dak1 strain and B5318PtacM3gldA::Cm/pMW-dak1 strain.

These strains were each cultured in L medium containing 20 mg/L of streptomycin or 20 mg/L of streptomycin and 50 mg/L of ampicillin at 37° C. until the final OD<sub>600</sub> became about 0.6, then a 40% glycerol solution in a volume equal to



the culture medium was added to each culture medium, and the mixture was stirred, then divided into appropriate volumes, and stored at  $-80^{\circ}\text{C}$ . These are called glycerol stocks.

## Example 4

Evaluation of L-Threonine-Producing Bacteria with Enhanced Glycerol Dehydrogenase and Dihydroxyacetone Kinase Activities

The aforementioned glycerol stocks of the strains were thawed, 100  $\mu\text{L}$  of each stock was uniformly applied to an L plate containing 20 mg/L of streptomycin or 20 mg/L of streptomycin and 50 mg/L of ampicillin, and culture was performed at  $37^{\circ}\text{C}$ . for 24 hours. The obtained cells on the plate were suspended in 1 ml of physiological saline, the suspension was inoculated in a volume (V) obtained by dividing a constant 50 with absorbance at 600 nm (n) of the suspension diluted 101 times ( $V=50/n$ ) into 20 mL of a fermentation medium containing 20 mg/L of streptomycin or 20 mg/L of streptomycin and 50 mg/L of ampicillin contained in a 500-mL conical flask with baffle, and culture was performed at  $40^{\circ}\text{C}$ . for 24 hours on a rotary culture machine. After the culture, amount of threonine accumulated in the medium was measured by a known method (Hitachi Liquid Chromatography ODS-2 Column).

The composition of the fermentation medium is shown below (unit: g/L).

Glycerol	40
$(\text{NH}_4)_2\text{SO}_4$	24
$\text{K}_2\text{HPO}_4$	1.0
$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$	1.0
$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$	0.01
$\text{MnSO}_4 \cdot 5\text{H}_2\text{O}$	0.01
Yeast extract	2.0
To final volume of 1 L	

The medium was adjusted to pH 7.0 with KOH, and autoclaved at  $115^{\circ}\text{C}$ . for 10 minutes, provided that glycerol and  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$  were separately sterilized, and 30 g/L of  $\text{CaCO}_3$  of Japanese Pharmacopoeia subjected to hot air sterilization at  $180^{\circ}\text{C}$ . for 2 hours was added.

As antibiotics, 20 mg/L of streptomycin or 20 mg/L of streptomycin and 50 mg/L of ampicillin were added. The culture was performed under the conditions of a temperature of  $40^{\circ}\text{C}$ . and stirring at 144 rpm for 24 hours.

The results are shown in Table 6 (OD means absorbance at 600 nm representing cell amount, Thr (g/L) means amount of L-threonine accumulated in flask, and yield (%) means yield of L-threonine based on the substrate). Whereas the strain in which only glycerol dehydrogenase was enhanced did not show change of yield and productivity compared with the non-modified strain, the B5318PtacM2gldA::Cm/pMW-dak1 strain and the B5318PtacM3gldA::Cm/pMW-dak1 strain in which both glycerol dehydrogenase and dihydroxyacetone kinase using ATP as a phosphate donor were enhanced accumulated a larger amount of L-threonine compared with the other strains.

TABLE 6

Table 6: L-Threonine accumulation of strains with enhanced glycerol dehydrogenase (gldA) and dihydroxyacetone kinase (dak1) activities

			OD600	Thr (g/L)	Yield (%)
5	B5318	—	22.5	12.5	30.9
	B5318	Ptac M2 gldA	21.5	11.9	29.4
	B5318	Ptac M2 gldA pMW-dak	21.1	13.2	32.6
	B5318	Ptac M3 gldA	23.1	12.3	30.4
10	B5318	Ptac M3 gldA pMW-dak	22.3	13.3	32.9

In the names of strains mentioned in the table, "pMW-dak1" is abbreviated as "pMW-dak", and "":Cm" is omitted.

## Explanation of Sequence Listing:

- SEQ ID NO: 1: gldA gene sequence of *Escherichia coli* (1104 bp)  
 SEQ ID NO: 2: GldA amino acid sequence of *Escherichia coli* (367 AA)  
 SEQ ID NO: 3: dakA1 gene sequence of *Saccharomyces cerevisiae* (1755 bp)  
 SEQ ID NO: 4: DakA amino acid sequence of *Saccharomyces cerevisiae* (584 AA)  
 SEQ ID NO: 5: dhbK1 gene sequence of *Agrobacterium tumefaciens* (1695 bp)  
 SEQ ID NO: 6: Dhbk1 amino acid sequence of *Agrobacterium tumefaciens* (564 AA)  
 SEQ ID NO: 7: dhaK gene sequence of *Citrobacter freundii* (1659 bp)  
 SEQ ID NO: 8: DhaK amino acid sequence of *Citrobacter freundii* (552 AA)  
 SEQ ID NO: 9: attR-cat-attL-ptacM-SD-spacer sequence (1740 bp)  
 SEQ ID NO: 10: tacM promoter (80 bp)  
 SEQ ID NO: 1: PtacMgldA::Cm sequence  
 SEQ ID NO: 12: atL-Ptac-gldA (PCR primer for enhancing gldA on chromosome)  
 SEQ ID NO: 13: atR-Ptac-fsaB1 (PCR primer for enhancing gldA on chromosome)  
 SEQ ID NO: 14: pMW-dak1F (primer for dakA cloning)  
 SEQ ID NO: 15: pMW-dak1R (primer for dak4 cloning)  
 SEQ ID NO: 16: glpF gene sequence of *Escherichia coli* (846 bp)  
 SEQ ID NO: 17: GlpF amino acid sequence of *Escherichia coli* (281 AA)  
 SEQ ID NO: 18: tpiA gene sequence of *Escherichia coli* (768 bp)  
 SEQ ID NO: 19: TpiA amino acid sequence of *Escherichia coli* (255 AA)  
 SEQ ID NO: 20: fbaA gene sequence of *Escherichia coli* (1080 bp)  
 SEQ ID NO: 21: FbaA amino acid sequence of *Escherichia coli* (359 AA)  
 SEQ ID NO: 22: glpX gene sequence of *Escherichia coli* (1011 bp)  
 SEQ ID NO: 23: GlpX amino acid sequence of *Escherichia coli* (336 AA)  
 SEQ ID NO: 24: glpK gene sequence of *Escherichia coli* (1509 bp)  
 SEQ ID NO: 25: GlpK amino acid sequence of *Escherichia coli* (502 AA)  
 SEQ ID NO: 26: glpA gene sequence of *Escherichia coli* (1629 bp)  
 SEQ ID NO: 27: GlpA amino acid sequence of *Escherichia coli* (542 AA)  
 SEQ ID NO: 28: glpB gene sequence of *Escherichia coli* (1260 bp)



SEQ ID NO: 29: GlpB amino acid sequence of *Escherichia coli* (419 AA)  
 SEQ ID NO: 30: glpC gene sequence of *Escherichia coli* (1191 bp)  
 SEQ ID NO: 31: GlpC amino acid sequence of *Escherichia coli* (396 AA)  
 SEQ ID NO: 32: glpD gene sequence of *Escherichia coli* (1506 bp)  
 SEQ ID NO: 33: GlpD amino acid sequence of *Escherichia coli* (501 AA)  
 SEQ ID NO: 34: dhaK gene sequence of *Escherichia coli* (1071 bp)  
 SEQ ID NO: 35: DhaK amino acid sequence of *Escherichia coli* (356 AA)  
 SEQ ID NO: 36: dhaL gene sequence of *Escherichia coli* (633 bp)  
 SEQ ID NO: 37: DhaL amino acid sequence of *Escherichia coli* (210 AA)  
 SEQ ID NO: 38: dhaM gene sequence of *Escherichia coli* (1419 bp)  
 SEQ ID NO: 39: DhaM amino acid sequence of *Escherichia coli* (472 AA)  
 SEQ ID NO: 40: Dihydroxyacetone kinase gene of *Schizosaccharomyces pombe* (1776 bp)  
 SEQ ID NO: 41: Dihydroxyacetone kinase of *Schizosaccharomyces pombe* (591 AA)  
 SEQ ID NO: 42: Dihydroxyacetone kinase gene of *Pichia angusta* (1830 bp)  
 SEQ ID NO: 43: Dihydroxyacetone kinase of *Pichia angusta* (609 AA)  
 SEQ ID NO: 44: Dihydroxyacetone kinase gene of *Pichia pastoris* (1827 bp)  
 SEQ ID NO: 45: Dihydroxyacetone kinase of *Pichia pastoris* (608 AA)  
 SEQ ID NO: 46: Dihydroxyacetone kinase gene of *Debaryomyces hansenii* (1824 bp)  
 SEQ ID NO: 47: Dihydroxyacetone kinase of *Debaryomyces hansenii* (607 AA)  
 SEQ ID NO: 48: Dihydroxyacetone kinase gene of *Escherichia blattae* (1752 bp)  
 SEQ ID NO: 49: Dihydroxyacetone kinase of *Escherichia blattae* (583 AA)  
 SEQ ID NO: 50: Dihydroxyacetone kinase gene of *Enterobacter* sp. 638 (1647 bp)  
 SEQ ID NO: 51: Dihydroxyacetone kinase of *Enterobacter* sp. 638 (548 AA)  
 SEQ ID NO: 52: Dihydroxyacetone kinase gene of *Psychromonas* sp. CNPT3 (1695 bp)  
 SEQ ID NO: 53: Dihydroxyacetone kinase of *Psychromonas* sp. CNPT3 (564 AA)  
 SEQ ID NO: 54: Dihydroxyacetone kinase gene of *Stappia aggregata* (1647 bp)  
 SEQ ID NO: 55: Dihydroxyacetone kinase of *Stappia aggregata* (548 AA)  
 SEQ ID NO: 56: Dihydroxyacetone kinase gene of *Rhizobium leguminosarum* bv. *viciae* 3841 (1641 bp)  
 SEQ ID NO: 57: Dihydroxyacetone kinase of *Rhizobium leguminosarum* bv. *viciae* 3841 (546 AA)  
 SEQ ID NO: 58: Dihydroxyacetone kinase gene of *Myxococcus xanthus* DK 1622 (1701 bp)  
 SEQ ID NO: 59: Dihydroxyacetone kinase of *Myxococcus xanthus* DK 1622 (566 AA)  
 SEQ ID NO: 60: Dihydroxyacetone kinase gene of *Burkholderia* sp. 383 (1701 bp)

SEQ ID NO: 61: Dihydroxyacetone kinase of *Burkholderia* sp. 383 (566 AA)  
 SEQ ID NO: 62: Dihydroxyacetone kinase gene of *Burkholderia thailandensis* E264 (1704 bp)  
 SEQ ID NO: 63: Dihydroxyacetone kinase of *Burkholderia thailandensis* E264 (567 AA)  
 SEQ ID NO: 64: Dihydroxyacetone kinase gene of *Burkholderia multivorans* ATCC 17616 (1851 bp)  
 SEQ ID NO: 65: Dihydroxyacetone kinase of *Burkholderia multivorans* ATCC 17616 (616 AA)  
 SEQ ID NO: 66: dhaR gene of *Escherichia coli* (1920 bp)  
 SEQ ID NO: 67: DhaR amino acid sequence of *Escherichia coli* (639 AA)  
 SEQ ID NO: 68: fsaA gene of *Escherichia coli* (663 bp)  
 SEQ ID NO: 69: FsaA amino acid sequence of *Escherichia coli* (220 AA)  
 SEQ ID NO: 70: fsaB gene of *Escherichia coli* (663 bp)  
 SEQ ID NO: 71: FsaB amino acid sequence of *Escherichia coli* (220 AA)  
 SEQ ID NO: 72: fbaB gene of *Escherichia coli* (1053 bp)  
 SEQ ID NO: 73: FbaB amino acid sequence of *Escherichia coli* (350 AA)  
 SEQ ID NO: 74: gldA gene of *Shigella dysenteriae* Sd197 (1143 bp)  
 SEQ ID NO: 75: GldA amino acid sequence of *Shigella dysenteriae* Sd197 (380 AA)  
 SEQ ID NO: 76: gldA gene of *Salmonella typhimurium* LT2 (1104 bp)  
 SEQ ID NO: 77: GldA amino acid sequence of *Salmonella typhimurium* LT2 (367 AA)  
 SEQ ID NO: 78: gldA gene of *Pseudomonas putida* (1098 bp)  
 SEQ ID NO: 79: GldA amino acid sequence of *Pseudomonas putida* (365 AA)  
 SEQ ID NO: 80: gldA gene of *Bacillus coagulans* 36D1 (1104 bp)  
 SEQ ID NO: 81: GldA amino acid sequence of *Bacillus coagulans* 36D1 (367 AA)  
 SEQ ID NO: 82: fbp gene of *Escherichia coli* (999 bp)  
 SEQ ID NO: 83: Fbp amino acid sequence of *Escherichia coli* (322 AA)  
 SEQ ID NO: 84: ybhA gene of *Escherichia coli* (819 bp)  
 SEQ ID NO: 85: YbhA amino acid sequence of *Escherichia coli* (272 AA)  
 SEQ ID NO: 86: ptsI gene of *Escherichia coli* (1782 bp)  
 SEQ ID NO: 87: PtsI amino acid sequence of *Escherichia coli* (575 AA)  
 SEQ ID NO: 88: attR-cat-attL-PtacM2-SD-spacer sequence  
 SEQ ID NO: 89: attR-cat-attL-PtacM3-SD-spacer sequence  
 SEQ ID NO: 90: PtacM2gldA::Cm sequence  
 SEQ ID NO: 91: PtacM3gldA::Cm sequence  
 SEQ ID NO: 92: PtacM fsaB-gldA::Cm sequence  
 SEQ ID NO: 93: atL-Ptac-fsaB (PCR primer for enhancing fsaB+gldA on chromosome)  
 SEQ ID NO: 94: atR-Ptac-fsaB (PCR primer for enhancing fsaB+gldA on chromosome)

## INDUSTRIAL APPLICABILITY

By using the microorganism of the present invention, efficient production of an L-amino acid from glycerol by fermentation is enabled.

While the invention has been described in detail with reference to exemplary embodiments thereof, it will be apparent to one skilled in the art that various changes can be made, and equivalents employed, without departing from the scope of the invention. Each of the aforementioned documents is incorporated by reference herein in its entirety.



## SEQUENCE LISTING

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<211> LENGTH: 1104

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<220> FEATURE:

<221> NAME/KEY: CDS

<222> LOCATION: (1)..(1104)

<400> SEQUENCE: 1

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Val Ile Asn Arg Leu Gly Glu Tyr Leu Lys Pro Leu Ala Glu Arg Trp
           20           25           30

tta gtg gtg ggt gac aaa ttt gtt tta ggt ttt gct caa tcc act gtc     144
Leu Val Val Gly Asp Lys Phe Val Leu Gly Phe Ala Gln Ser Thr Val
           35           40           45

gag aaa agc ttt aaa gat gct gga ctg gta gta gaa att gcg ccg ttt     192
Glu Lys Ser Phe Lys Asp Ala Gly Leu Val Val Glu Ile Ala Pro Phe
           50           55           60

ggc ggt gaa tgt tcg caa aat gag atc gac cgt ctg cgt ggc atc gcg     240
Gly Gly Glu Cys Ser Gln Asn Glu Ile Asp Arg Leu Arg Gly Ile Ala
           65           70           75           80

gag act gcg cag tgt ggc gca att ctc ggt atc ggt ggc gga aaa acc     288
Glu Thr Ala Gln Cys Gly Ala Ile Leu Gly Ile Gly Gly Gly Lys Thr
           85           90           95

ctc gat act gcc aaa gca ctg gca cat ttc atg ggt gtt ccg gta gcg     336
Leu Asp Thr Ala Lys Ala Leu Ala His Phe Met Gly Val Pro Val Ala
           100          105          110

atc gca ccg act atc gcc tct acc gat gca ccg tgc agc gca ttg tct     384
Ile Ala Pro Thr Ile Ala Ser Thr Asp Ala Pro Cys Ser Ala Leu Ser
           115          120          125

gtt atc tac acc gat gag ggt gag ttt gac cgc tat ctg ctg ttg cca     432
Val Ile Tyr Thr Asp Glu Gly Glu Phe Asp Arg Tyr Leu Leu Leu Pro
           130          135          140

aat aac ccg aat atg gtc att gtc gac acc aaa atc gtc gct ggc gca     480
Asn Asn Pro Asn Met Val Ile Val Asp Thr Lys Ile Val Ala Gly Ala
145          150          155          160

cct gca cgt ctg tta gcg gcg ggt atc ggc gat gcg ctg gca acc tgg     528
Pro Ala Arg Leu Leu Ala Ala Gly Ile Gly Asp Ala Leu Ala Thr Trp
           165          170          175

ttt gaa gcg cgt gcc tgc tct cgt agc ggc gcg acc acc atg gcg ggc     576
Phe Glu Ala Arg Ala Cys Ser Arg Ser Gly Ala Thr Thr Met Ala Gly
           180          185          190

ggc aag tgc acc cag gct gcg ctg gca ctg gct gaa ctg tgc tac aac     624
Gly Lys Cys Thr Gln Ala Ala Leu Ala Leu Ala Glu Leu Cys Tyr Asn
           195          200          205

acc ctg ctg gaa gaa ggc gaa aaa gcg atg ctt gct gcc gaa cag cat     672
Thr Leu Leu Glu Glu Gly Glu Lys Ala Met Leu Ala Ala Glu Gln His
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gta gtg act ccg gcg ctg gag cgc gtg att gaa gcg aac acc tat ttg     720
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cat aac ggc ctg acc gct atc ccg gac gcg cat cac tat tat cac ggt     816

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-continued

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Glu	Lys	Val	Ala	Phe	Gly	Thr	Leu	Thr	Gln	Leu	Val	Leu	Glu	Asn	Ala		
		275					280					285					
ccg	gtg	gag	gaa	atc	gaa	acc	gta	gct	gcc	ctt	agc	cat	gcg	gta	ggt		912
Pro	Val	Glu	Glu	Ile	Glu	Thr	Val	Ala	Ala	Leu	Ser	His	Ala	Val	Gly		
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ttg	cca	ata	act	ctc	gct	caa	ctg	gat	att	aaa	gaa	gat	gtc	ccg	gcg		960
Leu	Pro	Ile	Thr	Leu	Ala	Gln	Leu	Asp	Ile	Lys	Glu	Asp	Val	Pro	Ala		
305					310					315					320		
aaa	atg	cga	att	gtg	gca	gaa	gcg	gca	tgt	gca	gaa	ggt	gaa	acc	att		1008
Lys	Met	Arg	Ile	Val	Ala	Glu	Ala	Ala	Cys	Ala	Glu	Gly	Glu	Thr	Ile		
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cac	aac	atg	cct	ggc	ggc	gcg	acg	cca	gat	cag	ggt	tac	gcc	gct	ctg		1056
His	Asn	Met	Pro	Gly	Gly	Ala	Thr	Pro	Asp	Gln	Val	Tyr	Ala	Ala	Leu		
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ctg	gta	gcc	gac	cag	tac	ggt	cag	cgt	ttc	ctg	caa	gag	tgg	gaa	taa		1104
Leu	Val	Ala	Asp	Gln	Tyr	Gly	Gln	Arg	Phe	Leu	Gln	Glu	Trp	Glu			
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&lt;211&gt; LENGTH: 367

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Escherichia coli

&lt;400&gt; SEQUENCE: 2

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Leu	Val	Val	Gly	Asp	Lys	Phe	Val	Leu	Gly	Phe	Ala	Gln	Ser	Thr	Val		
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Glu	Lys	Ser	Phe	Lys	Asp	Ala	Gly	Leu	Val	Val	Glu	Ile	Ala	Pro	Phe		
	50				55						60						
Gly	Gly	Glu	Cys	Ser	Gln	Asn	Glu	Ile	Asp	Arg	Leu	Arg	Gly	Ile	Ala		
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Glu	Thr	Ala	Gln	Cys	Gly	Ala	Ile	Leu	Gly	Ile	Gly	Gly	Gly	Lys	Thr		
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Ile	Ala	Pro	Thr	Ile	Ala	Ser	Thr	Asp	Ala	Pro	Cys	Ser	Ala	Leu	Ser		
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Val	Ile	Tyr	Thr	Asp	Glu	Gly	Glu	Phe	Asp	Arg	Tyr	Leu	Leu	Leu	Pro		
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145				150						155				160			
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Phe	Glu	Ala	Arg	Ala	Cys	Ser	Arg	Ser	Gly	Ala	Thr	Thr	Met	Ala	Gly		
		180						185					190				
Gly	Lys	Cys	Thr	Gln	Ala	Ala	Leu	Ala	Leu	Ala	Glu	Leu	Cys	Tyr	Asn		
		195					200					205					
Thr	Leu	Leu	Glu	Glu	Gly	Glu	Lys	Ala	Met	Leu	Ala	Ala	Glu	Gln	His		
	210					215						220					
Val	Val	Thr	Pro	Ala	Leu	Glu	Arg	Val	Ile	Glu	Ala	Asn	Thr	Tyr	Leu		
					230					235					240		



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Ser Gly Val Gly Phe Glu Ser Gly Gly Leu Ala Ala Ala His Ala Val  
 245 250 255

His Asn Gly Leu Thr Ala Ile Pro Asp Ala His His Tyr Tyr His Gly  
 260 265 270

Glu Lys Val Ala Phe Gly Thr Leu Thr Gln Leu Val Leu Glu Asn Ala  
 275 280 285

Pro Val Glu Glu Ile Glu Thr Val Ala Ala Leu Ser His Ala Val Gly  
 290 295 300

Leu Pro Ile Thr Leu Ala Gln Leu Asp Ile Lys Glu Asp Val Pro Ala  
 305 310 315 320

Lys Met Arg Ile Val Ala Glu Ala Ala Cys Ala Glu Gly Glu Thr Ile  
 325 330 335

His Asn Met Pro Gly Gly Ala Thr Pro Asp Gln Val Tyr Ala Ala Leu  
 340 345 350

Leu Val Ala Asp Gln Tyr Gly Gln Arg Phe Leu Gln Glu Trp Glu  
 355 360 365

<210> SEQ ID NO 3  
 <211> LENGTH: 1755  
 <212> TYPE: DNA  
 <213> ORGANISM: *Saccharomyces cerevisiae*  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1755)

<400> SEQUENCE: 3

atg tcc gct aaa tcg ttt gaa gtc aca gat cca gtc aat tca agt ctc 48  
 Met Ser Ala Lys Ser Phe Glu Val Thr Asp Pro Val Asn Ser Ser Leu  
 1 5 10 15

aaa ggg ttt gcc ctt gct aac ccc tcc att acg ctg gtc cct gaa gaa 96  
 Lys Gly Phe Ala Leu Ala Asn Pro Ser Ile Thr Leu Val Pro Glu Glu  
 20 25 30

aaa att ctc ttc aga aag acc gat tcc gac aag atc gca tta att tct 144  
 Lys Ile Leu Phe Arg Lys Thr Asp Ser Asp Lys Ile Ala Leu Ile Ser  
 35 40 45

ggt ggt ggt agt gga cat gaa cct aca cac gcc ggt ttc att ggt aag 192  
 Gly Gly Gly Ser Gly His Glu Pro Thr His Ala Gly Phe Ile Gly Lys  
 50 55 60

ggt atg ttg agt ggc gcc gtg gtt ggc gaa att ttt gca tcc cct tca 240  
 Gly Met Leu Ser Gly Ala Val Val Gly Glu Ile Phe Ala Ser Pro Ser  
 65 70 75 80

aca aaa cag att tta aat gca atc cgt tta gtc aat gaa aat gcg tct 288  
 Thr Lys Gln Ile Leu Asn Ala Ile Arg Leu Val Asn Glu Asn Ala Ser  
 85 90 95

ggc gtt tta ttg att gtg aag aac tac aca ggt gat gtt ttg cat ttt 336  
 Gly Val Leu Leu Ile Val Lys Asn Tyr Thr Gly Asp Val Leu His Phe  
 100 105 110

ggt ctg tcc gct gag aga gca aga gcc ttg ggt att aac tgc cgc gtt 384  
 Gly Leu Ser Ala Glu Arg Ala Arg Ala Leu Gly Ile Asn Cys Arg Val  
 115 120 125

gct gtc ata ggt gat gat gtt gca gtt ggc aga gaa aag ggt ggt atg 432  
 Ala Val Ile Gly Asp Asp Val Ala Val Gly Arg Glu Lys Gly Gly Met  
 130 135 140

ggt ggt aga aga gca ttg gca ggt acc gtt ttg gtt cat aag att gta 480  
 Val Gly Arg Arg Ala Leu Ala Gly Thr Val Leu Val His Lys Ile Val  
 145 150 155 160

ggt gcc ttc gca gaa gaa tat tct agt aag tat ggc tta gac ggt aca 528  
 Gly Ala Phe Ala Glu Glu Tyr Ser Ser Lys Tyr Gly Leu Asp Gly Thr  
 165 170 175

gct aaa gtg gct aaa att atc aac gac aat ttg gtg acc att gga tct 576



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Ala	Lys	Val	Ala	Lys	Ile	Ile	Asn	Asp	Asn	Leu	Val	Thr	Ile	Gly	Ser	
			180					185					190			
tct	tta	gac	cat	tgt	aaa	ggt	cct	ggc	agg	aaa	ttc	gaa	agt	gaa	tta	624
Ser	Leu	Asp	His	Cys	Lys	Val	Pro	Gly	Arg	Lys	Phe	Glu	Ser	Glu	Leu	
		195					200					205				
aac	gaa	aaa	caa	atg	gaa	ttg	ggt	atg	ggt	att	cat	aac	gaa	cct	ggt	672
Asn	Glu	Lys	Gln	Met	Glu	Leu	Gly	Met	Gly	Ile	His	Asn	Glu	Pro	Gly	
	210					215					220					
gtg	aaa	ggt	tta	gac	cct	att	cct	tct	acc	gaa	gac	ttg	atc	tcc	aag	720
Val	Lys	Val	Leu	Asp	Pro	Ile	Pro	Ser	Thr	Glu	Asp	Leu	Ile	Ser	Lys	
	225				230					235					240	
tat	atg	cta	cca	aaa	cta	ttg	gat	cca	aac	gat	aag	gat	aga	gct	ttt	768
Tyr	Met	Leu	Pro	Lys	Leu	Leu	Asp	Pro	Asn	Asp	Lys	Asp	Arg	Ala	Phe	
				245					250					255		
gta	aag	ttt	gat	gaa	gat	gat	gaa	ggt	gtc	ttg	tta	ggt	aac	aat	ctc	816
Val	Lys	Phe	Asp	Glu	Asp	Asp	Glu	Val	Val	Leu	Leu	Val	Asn	Asn	Leu	
			260					265					270			
ggc	ggt	ggt	tct	aat	ttt	ggt	att	agt	tct	atc	act	tcc	aaa	act	acg	864
Gly	Gly	Val	Ser	Asn	Phe	Val	Ile	Ser	Ser	Ile	Thr	Ser	Lys	Thr	Thr	
		275					280					285				
gat	ttc	tta	aag	gaa	aat	tac	aac	ata	acc	ccg	ggt	caa	aca	att	gct	912
Asp	Phe	Leu	Lys	Glu	Asn	Tyr	Asn	Ile	Thr	Pro	Val	Gln	Thr	Ile	Ala	
	290					295					300					
ggc	aca	ttg	atg	acc	tcc	ttc	aat	ggt	aat	ggg	ttc	agt	atc	aca	tta	960
Gly	Thr	Leu	Met	Thr	Ser	Phe	Asn	Gly	Asn	Gly	Phe	Ser	Ile	Thr	Leu	
	305					310				315					320	
cta	aac	gcc	act	aag	gct	aca	aag	gct	ttg	caa	tct	gat	ttt	gag	gag	1008
Leu	Asn	Ala	Thr	Lys	Ala	Thr	Lys	Ala	Leu	Gln	Ser	Asp	Phe	Glu	Glu	
				325					330					335		
atc	aaa	tca	gta	cta	gac	ttg	ttg	aac	gca	ttt	acg	aac	gca	ccg	ggc	1056
Ile	Lys	Ser	Val	Leu	Asp	Leu	Leu	Asn	Ala	Phe	Thr	Asn	Ala	Pro	Gly	
			340					345					350			
tgg	cca	att	gca	gat	ttt	gaa	aag	act	tct	gcc	cca	tct	ggt	aac	gat	1104
Trp	Pro	Ile	Ala	Asp	Phe	Glu	Lys	Thr	Ser	Ala	Pro	Ser	Val	Asn	Asp	
		355					360					365				
gac	ttg	tta	cat	aat	gaa	gta	aca	gca	aag	gcc	gtc	ggt	acc	tat	gac	1152
Asp	Leu	Leu	His	Asn	Glu	Val	Thr	Ala	Lys	Ala	Val	Gly	Thr	Tyr	Asp	
	370					375					380					
ttt	gac	aag	ttt	gct	gag	tgg	atg	aag	agt	ggt	gct	gaa	caa	ggt	atc	1200
Phe	Asp	Lys	Phe	Ala	Glu	Trp	Met	Lys	Ser	Gly	Ala	Glu	Gln	Val	Ile	
	385				390					395					400	
aag	agc	gaa	ccg	cac	att	acg	gaa	cta	gac	aat	caa	ggt	ggt	gat	ggt	1248
Lys	Ser	Glu	Pro	His	Ile	Thr	Glu	Leu	Asp	Asn	Gln	Val	Gly	Asp	Gly	
				405					410					415		
gat	tgt	ggt	tac	act	tta	gtg	gca	gga	ggt	aaa	ggc	atc	acc	gaa	aac	1296
Asp	Cys	Gly	Tyr	Thr	Leu	Val	Ala	Gly	Val	Lys	Gly	Ile	Thr	Glu	Asn	
			420					425					430			
ctt	gac	aag	ctg	tcg	aag	gac	tca	tta	tct	cag	gcg	ggt	gcc	caa	att	1344
Leu	Asp	Lys	Leu	Ser	Lys	Asp	Ser	Leu	Ser	Gln	Ala	Val	Ala	Gln	Ile	
		435					440					445				
tca	gat	ttc	att	gaa	ggc	tca	atg	gga	ggt	act	tct	ggt	ggt	tta	tat	1392
Ser	Asp	Phe	Ile	Glu	Gly	Ser	Met	Gly	Gly	Thr	Ser	Gly	Gly	Leu	Tyr	
	450					455					460					
tct	att	ctt	ttg	tcg	ggt	ttt	tca	cac	gga	tta	att	cag	ggt	tgt	aaa	1440
Ser	Ile	Leu	Leu	Ser	Gly	Phe	Ser	His	Gly	Leu	Ile	Gln	Val	Cys	Lys	
	465				470					475					480	
tca	aag	gat	gaa	ccc	gtc	act	aag	gaa	att	gtg	gct	aag	tca	ctc	gga	1488
Ser	Lys	Asp	Glu	Pro	Val	Thr	Lys	Glu	Ile	Val	Ala	Lys	Ser	Leu	Gly	
				485					490					495		
att	gca	ttg	gat	act	tta	tac	aaa	tat	aca	aag	gca	agg	aag	gga	tca	1536



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Ile Ala Leu Asp Thr Leu Tyr Lys Tyr Thr Lys Ala Arg Lys Gly Ser
      500                    505                    510

tcc acc atg att gat gct tta gaa cca ttc gtt aaa gaa ttt act gca      1584
Ser Thr Met Ile Asp Ala Leu Glu Pro Phe Val Lys Glu Phe Thr Ala
      515                    520                    525

tct aag gat ttc aat aag gcg gta aaa gct gca gag gaa ggt gct aaa      1632
Ser Lys Asp Phe Asn Lys Ala Val Lys Ala Ala Glu Glu Gly Ala Lys
      530                    535                    540

tcc act gct aca ttc gag gcc aaa ttt ggc aga gct tcg tat gtc ggc      1680
Ser Thr Ala Thr Phe Glu Ala Lys Phe Gly Arg Ala Ser Tyr Val Gly
      545                    550                    555                    560

gat tca tct caa gta gaa gat cct ggt gca gta ggc cta tgt gag ttt      1728
Asp Ser Ser Gln Val Glu Asp Pro Gly Ala Val Gly Leu Cys Glu Phe
      565                    570                    575

ttg aag ggg gtt caa agc gcc ttg taa      1755
Leu Lys Gly Val Gln Ser Ala Leu
      580

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<210> SEQ ID NO 4
<211> LENGTH: 584
<212> TYPE: PRT
<213> ORGANISM: Saccharomyces cerevisiae

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<400> SEQUENCE: 4

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Met Ser Ala Lys Ser Phe Glu Val Thr Asp Pro Val Asn Ser Ser Leu
 1                    5                    10                    15

Lys Gly Phe Ala Leu Ala Asn Pro Ser Ile Thr Leu Val Pro Glu Glu
 20                    25                    30

Lys Ile Leu Phe Arg Lys Thr Asp Ser Asp Lys Ile Ala Leu Ile Ser
 35                    40                    45

Gly Gly Gly Ser Gly His Glu Pro Thr His Ala Gly Phe Ile Gly Lys
 50                    55                    60

Gly Met Leu Ser Gly Ala Val Val Gly Glu Ile Phe Ala Ser Pro Ser
 65                    70                    75                    80

Thr Lys Gln Ile Leu Asn Ala Ile Arg Leu Val Asn Glu Asn Ala Ser
 85                    90                    95

Gly Val Leu Leu Ile Val Lys Asn Tyr Thr Gly Asp Val Leu His Phe
100                    105                    110

Gly Leu Ser Ala Glu Arg Ala Arg Ala Leu Gly Ile Asn Cys Arg Val
115                    120                    125

Ala Val Ile Gly Asp Asp Val Ala Val Gly Arg Glu Lys Gly Gly Met
130                    135                    140

Val Gly Arg Arg Ala Leu Ala Gly Thr Val Leu Val His Lys Ile Val
145                    150                    155                    160

Gly Ala Phe Ala Glu Glu Tyr Ser Ser Lys Tyr Gly Leu Asp Gly Thr
165                    170                    175

Ala Lys Val Ala Lys Ile Ile Asn Asp Asn Leu Val Thr Ile Gly Ser
180                    185                    190

Ser Leu Asp His Cys Lys Val Pro Gly Arg Lys Phe Glu Ser Glu Leu
195                    200                    205

Asn Glu Lys Gln Met Glu Leu Gly Met Gly Ile His Asn Glu Pro Gly
210                    215                    220

Val Lys Val Leu Asp Pro Ile Pro Ser Thr Glu Asp Leu Ile Ser Lys
225                    230                    235                    240

Tyr Met Leu Pro Lys Leu Leu Asp Pro Asn Asp Lys Asp Arg Ala Phe
245                    250                    255

Val Lys Phe Asp Glu Asp Asp Glu Val Val Leu Leu Val Asn Asn Leu

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260					265					270					
Gly	Gly	Val	Ser	Asn	Phe	Val	Ile	Ser	Ser	Ile	Thr	Ser	Lys	Thr	Thr
		275					280					285			
Asp	Phe	Leu	Lys	Glu	Asn	Tyr	Asn	Ile	Thr	Pro	Val	Gln	Thr	Ile	Ala
	290					295					300				
Gly	Thr	Leu	Met	Thr	Ser	Phe	Asn	Gly	Asn	Gly	Phe	Ser	Ile	Thr	Leu
	305					310					315				320
Leu	Asn	Ala	Thr	Lys	Ala	Thr	Lys	Ala	Leu	Gln	Ser	Asp	Phe	Glu	Glu
				325					330					335	
Ile	Lys	Ser	Val	Leu	Asp	Leu	Leu	Asn	Ala	Phe	Thr	Asn	Ala	Pro	Gly
			340					345					350		
Trp	Pro	Ile	Ala	Asp	Phe	Glu	Lys	Thr	Ser	Ala	Pro	Ser	Val	Asn	Asp
		355					360					365			
Asp	Leu	Leu	His	Asn	Glu	Val	Thr	Ala	Lys	Ala	Val	Gly	Thr	Tyr	Asp
	370					375					380				
Phe	Asp	Lys	Phe	Ala	Glu	Trp	Met	Lys	Ser	Gly	Ala	Glu	Gln	Val	Ile
	385					390					395				400
Lys	Ser	Glu	Pro	His	Ile	Thr	Glu	Leu	Asp	Asn	Gln	Val	Gly	Asp	Gly
				405					410					415	
Asp	Cys	Gly	Tyr	Thr	Leu	Val	Ala	Gly	Val	Lys	Gly	Ile	Thr	Glu	Asn
			420					425						430	
Leu	Asp	Lys	Leu	Ser	Lys	Asp	Ser	Leu	Ser	Gln	Ala	Val	Ala	Gln	Ile
	435					440						445			
Ser	Asp	Phe	Ile	Glu	Gly	Ser	Met	Gly	Gly	Thr	Ser	Gly	Gly	Leu	Tyr
	450					455					460				
Ser	Ile	Leu	Leu	Ser	Gly	Phe	Ser	His	Gly	Leu	Ile	Gln	Val	Cys	Lys
	465					470					475				480
Ser	Lys	Asp	Glu	Pro	Val	Thr	Lys	Glu	Ile	Val	Ala	Lys	Ser	Leu	Gly
			485					490						495	
Ile	Ala	Leu	Asp	Thr	Leu	Tyr	Lys	Tyr	Thr	Lys	Ala	Arg	Lys	Gly	Ser
			500					505						510	
Ser	Thr	Met	Ile	Asp	Ala	Leu	Glu	Pro	Phe	Val	Lys	Glu	Phe	Thr	Ala
		515					520					525			
Ser	Lys	Asp	Phe	Asn	Lys	Ala	Val	Lys	Ala	Ala	Glu	Glu	Gly	Ala	Lys
	530					535					540				
Ser	Thr	Ala	Thr	Phe	Glu	Ala	Lys	Phe	Gly	Arg	Ala	Ser	Tyr	Val	Gly
	545					550					555				560
Asp	Ser	Ser	Gln	Val	Glu	Asp	Pro	Gly	Ala	Val	Gly	Leu	Cys	Glu	Phe
			565						570					575	
Leu	Lys	Gly	Val	Gln	Ser	Ala	Leu								
			580												

<210> SEQ ID NO 5  
 <211> LENGTH: 1695  
 <212> TYPE: DNA  
 <213> ORGANISM: Agrobacterium tumefaciens  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1695)  
 <400> SEQUENCE: 5

atg	aag	aag	ctc	atc	aac	gat	cca	tcc	acc	ggt	gtc	cgg	gac	atg	ctg	48
Met	Lys	Lys	Leu	Ile	Asn	Asp	Pro	Ser	Thr	Val	Val	Arg	Asp	Met	Leu	
1			5						10					15		
gag	ggc	atc	gtg	gcg	ctc	agc	ccc	gaa	acc	att	ctg	ctt	cag	gat	gag	96
Glu	Gly	Ile	Val	Ala	Leu	Ser	Pro	Glu	Thr	Ile	Leu	Leu	Gln	Asp	Glu	
			20						25					30		



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aac gtg gtc ata agg tcc ggc ctg cct gaa gcg gaa aag cgc aag gtt Asn Val Val Ile Arg Ser Gly Leu Pro Glu Ala Glu Lys Arg Lys Val 35 40 45	144
gca gtg ctt tcg ggc ggt ggc agc gga cat gag ccg gcc cac gcc ggt Ala Val Leu Ser Gly Gly Gly Ser Gly His Glu Pro Ala His Ala Gly 50 55 60	192
tat gtc ggc acg ggc atg ttg acg gtt gcg gtg gcg gcc gat gtc ttc Tyr Val Gly Thr Gly Met Leu Thr Val Ala Val Ala Gly Asp Val Phe 65 70 75 80	240
act tcg ccg agc acc gac gcg gtt ctc gcc gcc atc agg gcc gcg gcc Thr Ser Pro Ser Thr Asp Ala Val Leu Ala Gly Ile Arg Ala Ala Ala 85 90 95	288
ggc cct gcc ggt gcg ctg gtc atc gtc aag aac tat acc gcc gac cgg Gly Pro Ala Gly Ala Leu Val Ile Val Lys Asn Tyr Thr Gly Asp Arg 100 105 110	336
ctg aat ttc ggc ttg gcg gcg gag ctg gcg agg gcc gaa gga atc cct Leu Asn Phe Gly Leu Ala Ala Glu Leu Ala Arg Ala Glu Gly Ile Pro 115 120 125	384
gtc gag atc gtt gtc gtc gcc gac gac gtt gcc ttg aag gat acg gtt Val Glu Ile Val Val Val Ala Asp Asp Val Ala Leu Lys Asp Thr Val 130 135 140	432
ccc gcc gag cgc cgc cgc ggg att gcg ggg acg gtg ctc gtg cac aag Pro Ala Glu Arg Arg Arg Gly Ile Ala Gly Thr Val Leu Val His Lys 145 150 155 160	480
ctc gcg ggg gcc gca gcg gaa aag ggc ctt cct ctt caa gag gtg gcc Leu Ala Gly Ala Ala Ala Glu Lys Gly Leu Pro Leu Gln Glu Val Ala 165 170 175	528
cgc atc gcc cgg gac gct gcc gcc aag cta tot tcc atg ggt gtc tcg Arg Ile Ala Arg Asp Ala Ala Ala Lys Leu Ser Ser Met Gly Val Ser 180 185 190	576
ctg gga tcc tgc acg ctg ccg gct gtc ggc aag ccg gcc ttc gtg ctt Leu Gly Ser Cys Thr Leu Pro Ala Val Gly Lys Pro Gly Phe Val Leu 195 200 205	624
ggc gag acc gaa atc gaa gtc ggg ctc ggt atc cat gcc gag cag gcc Gly Glu Thr Glu Ile Glu Val Gly Leu Gly Ile His Gly Glu Gln Gly 210 215 220	672
gtg cag cgg atg ccc att gcc tcg gct gac gcg ctc gtg cag ctg gtg Val Gln Arg Met Pro Ile Ala Ser Ala Asp Ala Leu Val Gln Leu Val 225 230 235 240	720
atc gaa acg atc gaa gcc gac ggc aag ctc gcc gcc gcc aat cgc gtc Ile Glu Thr Ile Glu Ala Asp Gly Lys Leu Ala Gly Gly Asn Arg Val 245 250 255	768
gct ctg ctg gtc aac ggc ctg ggg gca acg ccg ccg atg gaa ctc gcc Ala Leu Leu Val Asn Gly Leu Gly Ala Thr Pro Pro Met Glu Leu Ala 260 265 270	816
atc gtc gca cgg tcg gca gtc gcg ccg ctg gag gcg aaa gcc atc gtc Ile Val Ala Arg Ser Ala Val Ala Arg Leu Glu Ala Lys Gly Ile Val 275 280 285	864
gtg gaa cgt gcc tgg gcc ggc acc ttc ctt tca gcc ctc gat atg ccc Val Glu Arg Ala Trp Ala Gly Thr Phe Leu Ser Ala Leu Asp Met Pro 290 295 300	912
ggg ttt tcg ttg tcg gtc atg cag gtt gac gac gca gcg ctc agc ctc Gly Phe Ser Leu Ser Val Met Gln Val Asp Asp Ala Ala Leu Ser Leu 305 310 315 320	960
atc gac gcg cca acc gag gct ggc gca tgg ccg cgc gcc ggt gcg gtg Ile Asp Ala Pro Thr Glu Ala Gly Ala Trp Pro Arg Gly Gly Ala Val 325 330 335	1008
aac cgc aag cgg gtt ctg cct tcg gca aac gcc gaa aag acc gtg gtt Asn Arg Lys Arg Val Leu Pro Ser Ala Asn Ala Glu Lys Thr Val Val 340 345 350	1056



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gcg aca aac aag atg acg gcg gcc gcc gag cgg ctt cgt tcg ggc gcg      1104
Ala Thr Asn Lys Met Thr Ala Ala Gly Glu Arg Leu Arg Ser Gly Ala
      355                360                365

gaa cgg tcc gcg aga gcc ctg atc gct gcg gag ccc agg ctg acg caa      1152
Glu Arg Ser Ala Arg Ala Leu Ile Ala Ala Glu Pro Arg Leu Thr Gln
      370                375                380

ctc gat agc gtt gca ggt gac gcc gac ctc ggc gcc agc atg gtg cgt      1200
Leu Asp Ser Val Ala Gly Asp Gly Asp Leu Gly Ala Ser Met Val Arg
385                390                395                400

ggc ggc gag gcg atc ctt gcg ctg ccg aaa gag agt ttc ggc gac gtc      1248
Gly Gly Glu Ala Ile Leu Ala Leu Pro Lys Glu Ser Phe Gly Asp Val
      405                410                415

tcc gat gga ttg atg gcg atg gcc aat gcg atg cgc aag gcc atc ggc      1296
Ser Asp Gly Leu Met Ala Met Ala Asn Ala Met Arg Lys Ala Ile Gly
      420                425                430

gga agc tcg ggg ccg ttc tat gcg aca ggc ctc atg cgc gct tcg cga      1344
Gly Ser Ser Gly Pro Phe Tyr Ala Thr Gly Leu Met Arg Ala Ser Arg
      435                440                445

cag ctg gca ggg atc gat gag cca gcg gcc cag cag atg gcg gaa gca      1392
Gln Leu Ala Gly Ile Asp Glu Pro Ala Ala Gln Gln Met Ala Glu Ala
      450                455                460

ttc gtg gcg gct gtt gcg gcg gtc tcg gaa ctt ggc ggt gcg aaa ccg      1440
Phe Val Ala Ala Val Ala Val Ser Glu Leu Gly Gly Ala Lys Pro
465                470                475                480

ggc gat cgc acg atg atc gat gcg ctt tat ccg gca gcg aaa acc ttc      1488
Gly Asp Arg Thr Met Ile Asp Ala Leu Tyr Pro Ala Ala Lys Thr Phe
      485                490                495

agg gac aag ctt gtg aca ggc gct tcg gca gaa gaa gcc tgg caa tcc      1536
Arg Asp Lys Leu Val Thr Gly Ala Ser Ala Glu Glu Ala Trp Gln Ser
      500                505                510

gcg gtg gcg gcg ggc gag gtg ggc gca gag gcg aca gcg tcc atg aag      1584
Ala Val Ala Ala Gly Glu Val Gly Ala Glu Ala Thr Ala Ser Met Lys
      515                520                525

cca cgg ctc ggg cgc gca agt tac ctc ggt gag cgg gcc gtc ggc cat      1632
Pro Arg Leu Gly Arg Ala Ser Tyr Leu Gly Glu Arg Ala Val Gly His
      530                535                540

ccc gat ggg ggc gcg gtc gcc gtt ggc atc tgg ctc aaa gct atc gag      1680
Pro Asp Gly Gly Ala Val Ala Val Gly Ile Trp Leu Lys Ala Ile Glu
545                550                555                560

gct gcg atc tcg tga
Ala Ala Ile Ser
      1695

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<210> SEQ ID NO 6
<211> LENGTH: 564
<212> TYPE: PRT
<213> ORGANISM: Agrobacterium tumefaciens

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<400> SEQUENCE: 6

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Met Lys Lys Leu Ile Asn Asp Pro Ser Thr Val Val Arg Asp Met Leu
1                5                10                15

Glu Gly Ile Val Ala Leu Ser Pro Glu Thr Ile Leu Leu Gln Asp Glu
      20                25                30

Asn Val Val Ile Arg Ser Gly Leu Pro Glu Ala Glu Lys Arg Lys Val
      35                40                45

Ala Val Leu Ser Gly Gly Gly Ser Gly His Glu Pro Ala His Ala Gly
      50                55                60

Tyr Val Gly Thr Gly Met Leu Thr Val Ala Val Ala Gly Asp Val Phe
65                70                75                80

Thr Ser Pro Ser Thr Asp Ala Val Leu Ala Gly Ile Arg Ala Ala Ala

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85					90					95					
Gly	Pro	Ala	Gly	Ala	Leu	Val	Ile	Val	Lys	Asn	Tyr	Thr	Gly	Asp	Arg
			100					105					110		
Leu	Asn	Phe	Gly	Leu	Ala	Ala	Glu	Leu	Ala	Arg	Ala	Glu	Gly	Ile	Pro
		115					120					125			
Val	Glu	Ile	Val	Val	Val	Ala	Asp	Asp	Val	Ala	Leu	Lys	Asp	Thr	Val
	130					135					140				
Pro	Ala	Glu	Arg	Arg	Arg	Gly	Ile	Ala	Gly	Thr	Val	Leu	Val	His	Lys
145						150					155				160
Leu	Ala	Gly	Ala	Ala	Ala	Glu	Lys	Gly	Leu	Pro	Leu	Gln	Glu	Val	Ala
				165					170					175	
Arg	Ile	Ala	Arg	Asp	Ala	Ala	Ala	Lys	Leu	Ser	Ser	Met	Gly	Val	Ser
			180					185					190		
Leu	Gly	Ser	Cys	Thr	Leu	Pro	Ala	Val	Gly	Lys	Pro	Gly	Phe	Val	Leu
		195					200					205			
Gly	Glu	Thr	Glu	Ile	Glu	Val	Gly	Leu	Gly	Ile	His	Gly	Glu	Gln	Gly
	210					215					220				
Val	Gln	Arg	Met	Pro	Ile	Ala	Ser	Ala	Asp	Ala	Leu	Val	Gln	Leu	Val
225						230					235				240
Ile	Glu	Thr	Ile	Glu	Ala	Asp	Gly	Lys	Leu	Ala	Gly	Gly	Asn	Arg	Val
			245						250					255	
Ala	Leu	Leu	Val	Asn	Gly	Leu	Gly	Ala	Thr	Pro	Pro	Met	Glu	Leu	Ala
			260					265					270		
Ile	Val	Ala	Arg	Ser	Ala	Val	Ala	Arg	Leu	Glu	Ala	Lys	Gly	Ile	Val
		275					280					285			
Val	Glu	Arg	Ala	Trp	Ala	Gly	Thr	Phe	Leu	Ser	Ala	Leu	Asp	Met	Pro
	290					295					300				
Gly	Phe	Ser	Leu	Ser	Val	Met	Gln	Val	Asp	Asp	Ala	Ala	Leu	Ser	Leu
305						310					315				320
Ile	Asp	Ala	Pro	Thr	Glu	Ala	Gly	Ala	Trp	Pro	Arg	Gly	Gly	Ala	Val
			325						330					335	
Asn	Arg	Lys	Arg	Val	Leu	Pro	Ser	Ala	Asn	Ala	Glu	Lys	Thr	Val	Val
			340					345					350		
Ala	Thr	Asn	Lys	Met	Thr	Ala	Ala	Gly	Glu	Arg	Leu	Arg	Ser	Gly	Ala
		355					360					365			
Glu	Arg	Ser	Ala	Arg	Ala	Leu	Ile	Ala	Ala	Glu	Pro	Arg	Leu	Thr	Gln
	370					375					380				
Leu	Asp	Ser	Val	Ala	Gly	Asp	Gly	Asp	Leu	Gly	Ala	Ser	Met	Val	Arg
385						390					395				400
Gly	Gly	Glu	Ala	Ile	Leu	Ala	Leu	Pro	Lys	Glu	Ser	Phe	Gly	Asp	Val
			405						410					415	
Ser	Asp	Gly	Leu	Met	Ala	Met	Ala	Asn	Ala	Met	Arg	Lys	Ala	Ile	Gly
			420					425					430		
Gly	Ser	Ser	Gly	Pro	Phe	Tyr	Ala	Thr	Gly	Leu	Met	Arg	Ala	Ser	Arg
		435					440					445			
Gln	Leu	Ala	Gly	Ile	Asp	Glu	Pro	Ala	Ala	Gln	Gln	Met	Ala	Glu	Ala
	450					455					460				
Phe	Val	Ala	Ala	Val	Ala	Ala	Val	Ser	Glu	Leu	Gly	Gly	Ala	Lys	Pro
465						470					475				480
Gly	Asp	Arg	Thr	Met	Ile	Asp	Ala	Leu	Tyr	Pro	Ala	Ala	Lys	Thr	Phe
			485						490					495	
Arg	Asp	Lys	Leu	Val	Thr	Gly	Ala	Ser	Ala	Glu	Glu	Ala	Trp	Gln	Ser
			500					505					510		



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Ala Val Ala Ala Gly Glu Val Gly Ala Glu Ala Thr Ala Ser Met Lys  
 515 520 525

Pro Arg Leu Gly Arg Ala Ser Tyr Leu Gly Glu Arg Ala Val Gly His  
 530 535 540

Pro Asp Gly Gly Ala Val Ala Val Gly Ile Trp Leu Lys Ala Ile Glu  
 545 550 555 560

Ala Ala Ile Ser

<210> SEQ ID NO 7  
 <211> LENGTH: 1659  
 <212> TYPE: DNA  
 <213> ORGANISM: Citrobacter freundii  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1659)

<400> SEQUENCE: 7

atg tct caa ttc ttt ttt aac caa cgc acc cat ctt gtg agc gac gtc	48
Met Ser Gln Phe Phe Phe Asn Gln Arg Thr His Leu Val Ser Asp Val	
1 5 10 15	
atc gac ggg gcg att atc gcc agc cca tgg aat aac ctg gcg cgt ctg	96
Ile Asp Gly Ala Ile Ile Ala Ser Pro Trp Asn Asn Leu Ala Arg Leu	
20 25 30	
gaa agc gat ccg gcc att cgc atc gtg gtc cgt cgt gac ctt aat aaa	144
Glu Ser Asp Pro Ala Ile Arg Ile Val Val Arg Arg Asp Leu Asn Lys	
35 40 45	
aat aac gta gcg gtc att tcc ggc ggc ggt tcg gga cac gaa ccc gcg	192
Asn Asn Val Ala Val Ile Ser Gly Gly Gly Ser Gly His Glu Pro Ala	
50 55 60	
cac gtt ggg ttt atc ggt aaa ggc atg cta acc gct gcg gtc tgc ggc	240
His Val Gly Phe Ile Gly Lys Gly Met Leu Thr Ala Ala Val Cys Gly	
65 70 75 80	
gac gtt ttc gcc tcc ccg agc gtg gat gct gta ctg acc gcg att cag	288
Asp Val Phe Ala Ser Pro Ser Val Asp Ala Val Leu Thr Ala Ile Gln	
85 90 95	
gcg gtg acc ggt gag gct ggc tgt ttg ttg att gtg aaa aac tac acc	336
Ala Val Thr Gly Glu Ala Gly Cys Leu Leu Ile Val Lys Asn Tyr Thr	
100 105 110	
ggt gac cgt ctt aat ttc ggt ctc gcc gcc gag aag gcg cgt cgc ctt	384
Gly Asp Arg Leu Asn Phe Gly Leu Ala Ala Glu Lys Ala Arg Arg Leu	
115 120 125	
ggc tat aac gtt gaa atg ctg att gtc ggc gac gac atc tcc ctg ccg	432
Gly Tyr Asn Val Glu Met Leu Ile Val Gly Asp Asp Ile Ser Leu Pro	
130 135 140	
gat aac aaa cac cca cgt ggc att gcg gga act atc ctg gtg cat aaa	480
Asp Asn Lys His Pro Arg Gly Ile Ala Gly Thr Ile Leu Val His Lys	
145 150 155 160	
atc gca ggc tat ttt gcc gaa cgc ggc tat aac ctc gcc acc gtc ctg	528
Ile Ala Gly Tyr Phe Ala Glu Arg Gly Tyr Asn Leu Ala Thr Val Leu	
165 170 175	
cgt gaa gcg cag tac gca gcc agc aac acc ttt agc ctg ggc gta gcg	576
Arg Glu Ala Gln Tyr Ala Ala Ser Asn Thr Phe Ser Leu Gly Val Ala	
180 185 190	
ctt tcc agc tgt cat ctg ccg caa gaa acc gac gca gcc cct cgt cat	624
Leu Ser Ser Cys His Leu Pro Gln Glu Thr Asp Ala Ala Pro Arg His	
195 200 205	
cat ccg ggt cat gcg gag ctg ggt atg gga att cac ggc gaa cca ggc	672
His Pro Gly His Ala Glu Leu Gly Met Gly Ile His Gly Glu Pro Gly	
210 215 220	
gca tcg gtt atc gac acc caa aac agt gcg caa gtg gta aac ctg atg	720
Ala Ser Val Ile Asp Thr Gln Asn Ser Ala Gln Val Val Asn Leu Met	



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225	230	235	240	
gtg gat aaa ctg ctg gcc gcc ctg cct gaa acc ggt cgt ctg gcg gtg Val Asp Lys Leu Leu Ala Ala Leu Pro Glu Thr Gly Arg Leu Ala Val	245	250	255	768
atg att aat aat ctt ggc ggc gtt tcc gtg gcc gaa atg gcc atc atc Met Ile Asn Asn Leu Gly Gly Val Ser Val Ala Glu Met Ala Ile Ile	260	265	270	816
acc cgc gaa ctc gcc agc agc ccg ctg cac tcg cgt atc gac tgg cta Thr Arg Glu Leu Ala Ser Ser Pro Leu His Ser Arg Ile Asp Trp Leu	275	280	285	864
att ggc ccg gcc tcg ctg gtc acc gcg ctg gat atg aaa ggc ttc tca Ile Gly Pro Ala Ser Leu Val Thr Ala Leu Asp Met Lys Gly Phe Ser	290	295	300	912
ctg acg gcc atc gtg ctg gaa gag agc atc gaa aaa gca ctg ctc acc Leu Thr Ala Ile Val Leu Glu Glu Ser Ile Glu Lys Ala Leu Leu Thr	305	310	315	960
gaa gtg gaa acc agc aac tgg ccg acg ccg gtc cca ccg cgt gaa atc Glu Val Glu Thr Ser Asn Trp Pro Thr Pro Val Pro Pro Arg Glu Ile	325	330	335	1008
acc tgc gta gtg tca tct cac gct agc gcc cgc gtg gaa ttc cag cct Thr Cys Val Val Ser Ser His Ala Ser Ala Arg Val Glu Phe Gln Pro	340	345	350	1056
tcg gca aac gcc ctg gtg gcc ggg att gtg gag ctg gtc acc gca acc Ser Ala Asn Ala Leu Val Ala Gly Ile Val Glu Leu Val Thr Ala Thr	355	360	365	1104
ctt tcc gat ctg gag act cat ctg aat gcg ctg gac gcc aaa gtc ggc Leu Ser Asp Leu Glu Thr His Leu Asn Ala Leu Asp Ala Lys Val Gly	370	375	380	1152
gat ggc gat acc ggt tcg acc ttt gcc gcc gcg gcg cgt gaa att gcc Asp Gly Asp Thr Gly Ser Thr Phe Ala Ala Ala Ala Arg Glu Ile Ala	385	390	395	1200
agc ctg ctg cat cgc cag cag ctg ccg ctg aat aac ctt gcc acg ctg Ser Leu Leu His Arg Gln Gln Leu Pro Leu Asn Asn Leu Ala Thr Leu	405	410	415	1248
ttc gcg ctg att ggc gaa cgt ctg acc gtg gtg atg ggc ggt tcc agc Phe Ala Leu Ile Gly Glu Arg Leu Thr Val Val Met Gly Gly Ser Ser	420	425	430	1296
ggt gtg ctg atg tca atc ttc ttt acc gcc gcc ggg cag aaa ctg gaa Gly Val Leu Met Ser Ile Phe Thr Ala Ala Gly Gln Lys Leu Glu	435	440	445	1344
cag ggc gct aac gtt gtc gaa gcg cta aat acg ggg ctg gcg cag atg Gln Gly Ala Asn Val Val Glu Ala Leu Asn Thr Gly Leu Ala Gln Met	450	455	460	1392
aag ttc tac ggc ggc gca gac gaa ggc gat cgc acg atg att gat gcg Lys Phe Tyr Gly Gly Ala Asp Glu Gly Asp Arg Thr Met Ile Asp Ala	465	470	475	1440
ctg caa ccg gcc ctg acc tcg ctg ctc gca cag ccg aaa aat ctg cag Leu Gln Pro Ala Leu Thr Ser Leu Leu Ala Gln Pro Lys Asn Leu Gln	485	490	495	1488
gcc gca ttc gac gcc gcg caa gcg gga gcc gaa cga acc tgt ttg tcg Ala Ala Phe Asp Ala Ala Gln Ala Gly Ala Glu Arg Thr Cys Leu Ser	500	505	510	1536
agc aaa gcc aat gcg ggt cgc gca tcg tat ctg agc agc gaa agc ctg Ser Lys Ala Asn Ala Gly Arg Ala Ser Tyr Leu Ser Ser Glu Ser Leu	515	520	525	1584
ctc gga aat atg gac ccc ggc gcg cag cgc cta gcg atg gtg ttt aaa Leu Gly Asn Met Asp Pro Gly Ala Gln Arg Leu Ala Met Val Phe Lys	530	535	540	1632
gcg cta gcg gag agt gag ctg ggc taa Ala Leu Ala Glu Ser Glu Leu Gly				1659



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545

550

<210> SEQ ID NO 8  
 <211> LENGTH: 552  
 <212> TYPE: PRT  
 <213> ORGANISM: Citrobacter freundii

&lt;400&gt; SEQUENCE: 8

Met Ser Gln Phe Phe Phe Asn Gln Arg Thr His Leu Val Ser Asp Val  
 1 5 10 15  
 Ile Asp Gly Ala Ile Ile Ala Ser Pro Trp Asn Asn Leu Ala Arg Leu  
 20 25 30  
 Glu Ser Asp Pro Ala Ile Arg Ile Val Val Arg Arg Asp Leu Asn Lys  
 35 40 45  
 Asn Asn Val Ala Val Ile Ser Gly Gly Gly Ser Gly His Glu Pro Ala  
 50 55 60  
 His Val Gly Phe Ile Gly Lys Gly Met Leu Thr Ala Ala Val Cys Gly  
 65 70 75 80  
 Asp Val Phe Ala Ser Pro Ser Val Asp Ala Val Leu Thr Ala Ile Gln  
 85 90 95  
 Ala Val Thr Gly Glu Ala Gly Cys Leu Leu Ile Val Lys Asn Tyr Thr  
 100 105 110  
 Gly Asp Arg Leu Asn Phe Gly Leu Ala Ala Glu Lys Ala Arg Arg Leu  
 115 120 125  
 Gly Tyr Asn Val Glu Met Leu Ile Val Gly Asp Asp Ile Ser Leu Pro  
 130 135 140  
 Asp Asn Lys His Pro Arg Gly Ile Ala Gly Thr Ile Leu Val His Lys  
 145 150 155 160  
 Ile Ala Gly Tyr Phe Ala Glu Arg Gly Tyr Asn Leu Ala Thr Val Leu  
 165 170 175  
 Arg Glu Ala Gln Tyr Ala Ala Ser Asn Thr Phe Ser Leu Gly Val Ala  
 180 185 190  
 Leu Ser Ser Cys His Leu Pro Gln Glu Thr Asp Ala Ala Pro Arg His  
 195 200 205  
 His Pro Gly His Ala Glu Leu Gly Met Gly Ile His Gly Glu Pro Gly  
 210 215 220  
 Ala Ser Val Ile Asp Thr Gln Asn Ser Ala Gln Val Val Asn Leu Met  
 225 230 235 240  
 Val Asp Lys Leu Leu Ala Ala Leu Pro Glu Thr Gly Arg Leu Ala Val  
 245 250 255  
 Met Ile Asn Asn Leu Gly Gly Val Ser Val Ala Glu Met Ala Ile Ile  
 260 265 270  
 Thr Arg Glu Leu Ala Ser Ser Pro Leu His Ser Arg Ile Asp Trp Leu  
 275 280 285  
 Ile Gly Pro Ala Ser Leu Val Thr Ala Leu Asp Met Lys Gly Phe Ser  
 290 295 300  
 Leu Thr Ala Ile Val Leu Glu Glu Ser Ile Glu Lys Ala Leu Leu Thr  
 305 310 315 320  
 Glu Val Glu Thr Ser Asn Trp Pro Thr Pro Val Pro Pro Arg Glu Ile  
 325 330 335  
 Thr Cys Val Val Ser Ser His Ala Ser Ala Arg Val Glu Phe Gln Pro  
 340 345 350  
 Ser Ala Asn Ala Leu Val Ala Gly Ile Val Glu Leu Val Thr Ala Thr  
 355 360 365  
 Leu Ser Asp Leu Glu Thr His Leu Asn Ala Leu Asp Ala Lys Val Gly



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370	375	380
Asp Gly Asp Thr Gly Ser Thr Phe Ala Ala Ala Ala Arg Glu Ile Ala 385	390	395
Ser Leu Leu His Arg Gln Gln Leu Pro Leu Asn Asn Leu Ala Thr Leu 405	410	415
Phe Ala Leu Ile Gly Glu Arg Leu Thr Val Val Met Gly Gly Ser Ser 420	425	430
Gly Val Leu Met Ser Ile Phe Phe Thr Ala Ala Gly Gln Lys Leu Glu 435	440	445
Gln Gly Ala Asn Val Val Glu Ala Leu Asn Thr Gly Leu Ala Gln Met 450	455	460
Lys Phe Tyr Gly Gly Ala Asp Glu Gly Asp Arg Thr Met Ile Asp Ala 465	470	475
Leu Gln Pro Ala Leu Thr Ser Leu Leu Ala Gln Pro Lys Asn Leu Gln 485	490	495
Ala Ala Phe Asp Ala Ala Gln Ala Gly Ala Glu Arg Thr Cys Leu Ser 500	505	510
Ser Lys Ala Asn Ala Gly Arg Ala Ser Tyr Leu Ser Ser Glu Ser Leu 515	520	525
Leu Gly Asn Met Asp Pro Gly Ala Gln Arg Leu Ala Met Val Phe Lys 530	535	540
Ala Leu Ala Glu Ser Glu Leu Gly 545	550	

&lt;210&gt; SEQ ID NO 9

&lt;211&gt; LENGTH: 1740

&lt;212&gt; TYPE: DNA

&lt;213&gt; ORGANISM: Artificial sequence

&lt;220&gt; FEATURE:

&lt;223&gt; OTHER INFORMATION: attR-cat-attL-PtacM-SD-spacer

&lt;400&gt; SEQUENCE: 9

tctagacgct caagttagta taaaaaagct gaacgagaaa cgtaaaatga tataaatatc	60
aatatattaa attagatttt gcataaaaaa cagactacat aatactgtaa aacacaacat	120
atgcagtcac tatgaatcaa ctacttagat ggtattagtg acctgtaaca gactgcagtg	180
gtcgaaaaaa aaagcccgca ctgtcagggtg cgggcttttt tctgtgttaa gcttcgacga	240
atctctgcca ttcacccgct tattatcact tttcaggcgt tagcaccagg cgtttaaggg	300
caccaataac tgccttaaaa aaattacgcc ccgcccctgcc actcatcgca gtactgttgt	360
aattcattaa gcattctgcc gacatggaag ccatcacaga cggcatgatg aacctgaatc	420
gccagcggca tcagcacctt gtgccttgc gtataatatt tgcccattggt gaaaacgggg	480
gcgaagaagt tgtccatatt ggccacgttt aaatcaaac tggtgaaact caccagggga	540
ttggctgaga cgaaaaacat attctcaata aacccttttag ggaaataggc caggttttca	600
ccgtaacacg ccacatcttg cgaatatatg tgtagaaact gccggaatc gtcgtggtat	660
tcactccaga gcgatgaaaa cgtttcagtt tgctcatgga aaacgggtga acaaggtgta	720
acactatccc atatcaccag ctcaccgtct ttcattgcca tacggaattc cggatgagca	780
ttcatcaggc gggcaagaat gtgaataaag gccggataaa acttgtgctt atttttcttt	840
acggctcttta aaaaggccgt aatatccagc tgaacggctc ggttataggt acattgagca	900
actgactgaa atgcctcaa atgttcttta cgatgccatt gggatatatc aacgggtgta	960
tatccagtga tttttttctc catttttagct tccttagctc ctgaaaatct cggatccggc	1020
caagctagct tggctctagc tagagcgcgc ggttgacgct gctagtgtta cctagcgatt	1080



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tgtatcttac tgcattgttac ttcattgttgt caatacctgt ttttcgtgcg acttatcagg 1140
ctgtctactt atccggagat ccacaggacg ggtgtggtcg ccatgatcgc gtagtcgata 1200
gtggctccaa gtagcgaagc gagcaggact gggcggcggc caaagcggtc ggacagtgc 1260
ccgagaacgg gtgcgcatag aaattgcatc aacgcatata gcgctagcag cacgccatag 1320
tgactggcga tgctgtcggg atggacgata tcccgaaga ggcccggcag taccggcata 1380
accaagccta tgcctacagc atccaggggtg acggtgccga ggatgacgat gaggcattg 1440
ttagatttca tacacgggtc ctgactgcgt tagcaattta actgtgataa actaccgcat 1500
taaagcttat cgatgataag ctgtcaaaca tgagaattcg aaatcaaata atgattttat 1560
ttgactgat agtgacctgt tcggtgcaac aaattgataa gcaatgcttt tttataatgc 1620
caacttagta taaaaaagca ggcttcaaga tctctcccca tcccctggt cacaattaat 1680
catcggctcg tataatgtgt ggaattgtga gcggataaca atttcacaca ggagactgcc 1740

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<210> SEQ ID NO 10
<211> LENGTH: 80
<212> TYPE: DNA
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: PtacM
<220> FEATURE:
<221> NAME/KEY: promoter
<222> LOCATION: (1)..(80)
<223> OTHER INFORMATION: PtacM

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<400> SEQUENCE: 10

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ctccccatcc cctgtttcac aattaatcat cggctcgtat aatgtgtgga attgtgagcg 60
gataacaatt tcacacagga 80

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<210> SEQ ID NO 11
<211> LENGTH: 2844
<212> TYPE: DNA
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: PtacMgldA::Cm

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<400> SEQUENCE: 11

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tctagacgct caagttagta taaaaaagct gaacgagaaa cgtaaaatga tataaatatc 60
aatatattaa attagatttt gcataaaaaa cagactacat aatactgtaa aacacaacat 120
atgcagtcac tatgaatcaa ctacttagat ggtattagtg acctgtaaca gactgcagtg 180
gtcgaaaaaa aaagcccgcg ctgtcagggtg cgggcttttt tctgtgtaa gcttcgacga 240
atctctgcca ttcattccgt tattatcact tattcaggcg tagcaccagg cgtttaaggg 300
caccaataac tgccttaaaa aaattacgcc ccgcccctgcc actcatcgca gtactggtgt 360
aattcattaa gcattctgcc gacatggaag ccatcacaga cggcatgatg aacctgaatc 420
gccagcggca tcagcacctt gtcgccttgc gtataatatt tgcccattgt gaaaacgggg 480
gcgaagaagt tgtccatatt ggccacggtt aaatcaaac tggtgaaact caccagggg 540
ttggctgaga cgaaaaacat attctcaata aacccttagg ggaaataggc caggttttca 600
ccgtaaacacg ccacatcttg cgaatatatg tgtagaaaact gccggaaatc gtctggttat 660
tactccaga gcgatgaaaa cgtttcagtt tgctcatgga aaacgggtga acaaggggtga 720
acactatccc atatcaccag ctaccgtctt ttcattgcca tacggaattc cggatgagca 780
ttcatcaggc gggcaagaat gtgaataaag gccggataaa acttgtgctt atttttcttt 840
acggtcttta aaaaggcgtt aatatccagc tgaacggctt gggttatagg acattgagca 900

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actgactgaa atgcctcaaa atgttcttta cgatgccatt gggatatatc aacggtggtta 960
tatccagtga tttttttctc catttttagct tccttagctc ctgaaaatct cggatccggc 1020
caagctagct tggctctagc tagagcgecc ggttgacgct gctagtgtta cctagcagatt 1080
tgtatcttac tgcattgttac ttcattgttg caatacctgt ttttcgtgcg acttatcagg 1140
ctgtctactt atccggagat ccacaggacg ggtgtggctg ccatgatcgc gtagtcgata 1200
gtggctccaa gtagcgaagc gagcaggact gggcggcgcc caaagcggtc ggacagtgct 1260
ccgagaacgg gtgcgcatag aaattgcatc aacgcatata gcgctagcag cacgccatag 1320
tgactggcga tgctgtcggg atggacgata tcccgcgaaga ggcccggcag taccggcata 1380
accaagccta tgcctacagc atccaggggtg acggtgccga ggatgacgat gagcgcattg 1440
ttagatttca tacacgggtgc ctgactgctg tagcaattta actgtgataa actaccgcat 1500
taaagcttat cgatgataag ctgtcaaaca tgagaattcg aaatcaaata atgattttat 1560
tttgactgat agtgacctgt tcggtgcaac aaattgataa gcaatgcttt tttataatgc 1620
caacttagta taaaaaagca ggcttcaaga tctctcccca tcccctggt cacaattaat 1680
catcggctcg tataatgtgt ggaattgtga gcgataaaca atttcacaca ggagactgcc 1740
atggaccgca ttattcaatc accgggtaaa tacatccagg gcgctgatgt gattaatcgt 1800
ctgggcgaat acctgaagcc gctggcagaa cgctgggttag tgggtgggtga caaatttgtt 1860
ttaggttttg ctcaatccac tgtcgagaaa agctttaaag atgctggact ggtagtagaa 1920
attgcgcctg ttggcgggtg atgttcgcaa aatgagatcg accgtctgcg tggcatcgcg 1980
gagactgccc agtgtggcgc aattctcggg atcgggtggcg gaaaaaccct cgatactgcc 2040
aaagcactgg cacatttcat ggggtgttccg gtagegatcg caccgactat cgcctctacc 2100
gatgcaccgt gcagcgcatt gtctgttacc tacaccgatg aggggtgagtt tgaccgctat 2160
ctgctgttgc caaataaccg gaatatggtc attgtcgaca ccaaaatcgt cgctggcgca 2220
cctgcacgtc tgttagcggc ggggtatcggc gatgcgctgg caacctggtt tgaagcgcgt 2280
gcctgctctc gtagcggcgc gaccaccatg gcggcgccga agtgcacca ggctgcgctg 2340
gcaactggctg aactgtgcta caacaccctg ctggaagaag gcgaaaaagc gatgcttgc 2400
gccgaacagc atgtagtgac tccggcgtg gagcgcgtga ttgaagcga cactatttg 2460
agcgggtgtg gttttgaaag tgggtggtctg gctgcggcgc acgcagtga taacggcctg 2520
accgctatcc cggacgcgca tcaactattat cacgggtgaaa aagtggcatt cggtagcctg 2580
acgcagctgg ttctggaaaa tgcgcgggtg gaggaatcg aaaccgtagc tgcccttagc 2640
catgcggtag gtttgcaat aactctcgt caactggata ttaaagaaga tgtcccggcg 2700
aaaatgcgaa ttgtggcaga agcggcatgt gcagaagggtg aaaccattca caacatgcct 2760
ggcggcgcga cgcagatca ggtttacgcc gctctgctgg tagccgacca gtacggctag 2820
cgtttcctgc aagagtggga ataa 2844

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&lt;210&gt; SEQ ID NO 12

&lt;211&gt; LENGTH: 77

&lt;212&gt; TYPE: DNA

&lt;213&gt; ORGANISM: Artificial sequence

&lt;220&gt; FEATURE:

&lt;223&gt; OTHER INFORMATION: atL-ptac-gldA

&lt;400&gt; SEQUENCE: 12

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acatcagcgc cctggatgta tttaccgggt gattgaataa tgccgtccat ggcagtctcc 60

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tgtgtgaaat tggtatc

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77



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<210> SEQ ID NO 13  
 <211> LENGTH: 77  
 <212> TYPE: DNA  
 <213> ORGANISM: Artificial sequence  
 <220> FEATURE:  
 <223> OTHER INFORMATION: atL-Ptac-fsaB1  
  
 <400> SEQUENCE: 13  
  
 aacgccgct ctgccgacgc tatcgccagc ctgctgcaac atgaactgga actgtaaacc 60  
 tagacgctca agttagt 77

<210> SEQ ID NO 14  
 <211> LENGTH: 50  
 <212> TYPE: DNA  
 <213> ORGANISM: Artificial sequence  
 <220> FEATURE:  
 <223> OTHER INFORMATION: pMW-dak1F  
  
 <400> SEQUENCE: 14  
  
 tgattacgcc aagcttagga ggttaaagt cgcctaaatc gtttgaagtc 50

<210> SEQ ID NO 15  
 <211> LENGTH: 52  
 <212> TYPE: DNA  
 <213> ORGANISM: Artificial sequence  
 <220> FEATURE:  
 <223> OTHER INFORMATION: pMW-dak1R  
  
 <400> SEQUENCE: 15  
  
 atcctctaga gtcgacgcgg ccgctactta caaggcgctt tgaaccccct tc 52

<210> SEQ ID NO 16  
 <211> LENGTH: 846  
 <212> TYPE: DNA  
 <213> ORGANISM: Escherichia coli  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(846)  
  
 <400> SEQUENCE: 16  
  
 atg agt caa aca tca acc ttg aaa ggc cag tgc att gct gaa ttc ctc 48  
 Met Ser Gln Thr Ser Thr Leu Lys Gly Gln Cys Ile Ala Glu Phe Leu  
 1 5 10 15  
  
 ggt acc ggg ttg ttg att ttc ttc ggt gtg ggt tgc gtt gca gca cta 96  
 Gly Thr Gly Leu Leu Ile Phe Phe Gly Val Gly Cys Val Ala Ala Leu  
 20 25 30  
  
 aaa gtc gct ggt gcg tct ttt ggt cag tgg gaa atc agt gtc att tgg 144  
 Lys Val Ala Gly Ala Ser Phe Gly Gln Trp Glu Ile Ser Val Ile Trp  
 35 40 45  
  
 gga ctg ggg gtg gca atg gcc atc tac ctg acc gca ggg gtt tcc ggc 192  
 Gly Leu Gly Val Ala Met Ala Ile Tyr Leu Thr Ala Gly Val Ser Gly  
 50 55 60  
  
 gcg cat ctt aat ccc gct gtt acc att gca ttg tgg ctg ttt gcc tgt 240  
 Ala His Leu Asn Pro Ala Val Thr Ile Ala Leu Trp Leu Phe Ala Cys  
 65 70 75 80  
  
 ttc gac aag cgc aaa gtt att cct ttt atc gtt tca caa gtt gcc ggc 288  
 Phe Asp Lys Arg Lys Val Ile Pro Phe Ile Val Ser Gln Val Ala Gly  
 85 90 95  
  
 gct ttc tgt gct gcg gct tta gtt tac ggg ctt tac tac aat tta ttt 336  
 Ala Phe Cys Ala Ala Ala Leu Val Tyr Gly Leu Tyr Tyr Asn Leu Phe  
 100 105 110  
  
 ttc gac ttc gag cag act cat cac att gtt cgc ggc agc gtt gaa agt 384  
 Phe Asp Phe Glu Gln Thr His His Ile Val Arg Gly Ser Val Glu Ser



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115	120	125	
ggt gat ctg gct ggc act ttc tct act tac cct aat cct cat atc aat			432
Val Asp Leu Ala Gly Thr Phe Ser Thr Tyr Pro Asn Pro His Ile Asn			
130	135	140	
ttt gtg cag gct ttc gca gtt gag atg gtg att acc gct att ctg atg			480
Phe Val Gln Ala Phe Ala Val Glu Met Val Ile Thr Ala Ile Leu Met			
145	150	155	160
ggg ctg atc ctg gcg tta acg gac gat ggc aac ggt gta cca cgc ggc			528
Gly Leu Ile Leu Ala Leu Thr Asp Asp Gly Asn Gly Val Pro Arg Gly			
165	170	175	
cct ttg gct ccc ttg ctg att ggt cta ctg att gcg gtc att ggc gca			576
Pro Leu Ala Pro Leu Leu Ile Gly Leu Leu Ile Ala Val Ile Gly Ala			
180	185	190	
tct atg ggc cca ttg aca ggt ttt gcc atg aac cca gcg cgt gac ttc			624
Ser Met Gly Pro Leu Thr Gly Phe Ala Met Asn Pro Ala Arg Asp Phe			
195	200	205	
ggt ccg aaa gtc ttt gcc tgg ctg gcg ggc tgg ggc aat gtc gcc ttt			672
Gly Pro Lys Val Phe Ala Trp Leu Ala Gly Trp Gly Asn Val Ala Phe			
210	215	220	
acc ggc ggc aga gac att cct tac ttc ctg gtg ccg ctt ttc ggc cct			720
Thr Gly Gly Arg Asp Ile Pro Tyr Phe Leu Val Pro Leu Phe Gly Pro			
225	230	235	240
atc gtt ggc gcg att gta ggt gca ttt gcc tac cgc aaa ctg att ggt			768
Ile Val Gly Ala Ile Val Gly Ala Phe Ala Tyr Arg Lys Leu Ile Gly			
245	250	255	
cgc cat ttg cct tgc gat atc tgt gtt gtg gaa gaa aag gaa acc aca			816
Arg His Leu Pro Cys Asp Ile Cys Val Val Glu Glu Lys Glu Thr Thr			
260	265	270	
act cct tca gaa caa aaa gct tcg ctg taa			846
Thr Pro Ser Glu Gln Lys Ala Ser Leu			
275	280		

&lt;210&gt; SEQ ID NO 17

&lt;211&gt; LENGTH: 281

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Escherichia coli

&lt;400&gt; SEQUENCE: 17

Met Ser Gln Thr Ser Thr Leu Lys Gly Gln Cys Ile Ala Glu Phe Leu			
1	5	10	15
Gly Thr Gly Leu Leu Ile Phe Phe Gly Val Gly Cys Val Ala Ala Leu			
20	25	30	
Lys Val Ala Gly Ala Ser Phe Gly Gln Trp Glu Ile Ser Val Ile Trp			
35	40	45	
Gly Leu Gly Val Ala Met Ala Ile Tyr Leu Thr Ala Gly Val Ser Gly			
50	55	60	
Ala His Leu Asn Pro Ala Val Thr Ile Ala Leu Trp Leu Phe Ala Cys			
65	70	75	80
Phe Asp Lys Arg Lys Val Ile Pro Phe Ile Val Ser Gln Val Ala Gly			
85	90	95	
Ala Phe Cys Ala Ala Ala Leu Val Tyr Gly Leu Tyr Tyr Asn Leu Phe			
100	105	110	
Phe Asp Phe Glu Gln Thr His His Ile Val Arg Gly Ser Val Glu Ser			
115	120	125	
Val Asp Leu Ala Gly Thr Phe Ser Thr Tyr Pro Asn Pro His Ile Asn			
130	135	140	
Phe Val Gln Ala Phe Ala Val Glu Met Val Ile Thr Ala Ile Leu Met			
145	150	155	160



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Gly Leu Ile Leu Ala Leu Thr Asp Asp Gly Asn Gly Val Pro Arg Gly  
 165 170 175

Pro Leu Ala Pro Leu Leu Ile Gly Leu Leu Ile Ala Val Ile Gly Ala  
 180 185 190

Ser Met Gly Pro Leu Thr Gly Phe Ala Met Asn Pro Ala Arg Asp Phe  
 195 200 205

Gly Pro Lys Val Phe Ala Trp Leu Ala Gly Trp Gly Asn Val Ala Phe  
 210 215 220

Thr Gly Gly Arg Asp Ile Pro Tyr Phe Leu Val Pro Leu Phe Gly Pro  
 225 230 235 240

Ile Val Gly Ala Ile Val Gly Ala Phe Ala Tyr Arg Lys Leu Ile Gly  
 245 250 255

Arg His Leu Pro Cys Asp Ile Cys Val Val Glu Glu Lys Glu Thr Thr  
 260 265 270

Thr Pro Ser Glu Gln Lys Ala Ser Leu  
 275 280

<210> SEQ ID NO 18  
 <211> LENGTH: 768  
 <212> TYPE: DNA  
 <213> ORGANISM: Escherichia coli  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(768)

<400> SEQUENCE: 18

atg cga cat cct tta gtg atg ggt aac tgg aaa ctg aac ggc agc cgc 48  
 Met Arg His Pro Leu Val Met Gly Asn Trp Lys Leu Asn Gly Ser Arg  
 1 5 10 15

cac atg gtt cac gag ctg gtt tct aac ctg cgt aaa gag ctg gca ggt 96  
 His Met Val His Glu Leu Val Ser Asn Leu Arg Lys Glu Leu Ala Gly  
 20 25 30

gtt gct ggc tgt gcg gtt gca atc gca cca ccg gaa atg tat atc gat 144  
 Val Ala Gly Cys Ala Val Ala Ile Ala Pro Pro Glu Met Tyr Ile Asp  
 35 40 45

atg gcg aag cgc gaa gct gaa ggc agc cac atc atg ctg ggt gcg caa 192  
 Met Ala Lys Arg Glu Ala Glu Gly Ser His Ile Met Leu Gly Ala Gln  
 50 55 60

aac gtg gac ctg aac ctg tcc ggc gca ttc acc ggt gaa acc tct gct 240  
 Asn Val Asp Leu Asn Leu Ser Gly Ala Phe Thr Gly Glu Thr Ser Ala  
 65 70 75 80

gct atg ctg aaa gac atc ggc gca cag tac atc atc atc ggt cac tct 288  
 Ala Met Leu Lys Asp Ile Gly Ala Gln Tyr Ile Ile Ile Gly His Ser  
 85 90 95

gaa cgt cgt act tac cac aaa gaa tct gac gaa ctg atc gcg aaa aaa 336  
 Glu Arg Arg Thr Tyr His Lys Glu Ser Asp Glu Leu Ile Ala Lys Lys  
 100 105 110

ttc gcg gtg ctg aaa gag cag ggc ctg act ccg gtt ctg tgc atc ggt 384  
 Phe Ala Val Leu Lys Glu Gln Gly Leu Thr Pro Val Leu Cys Ile Gly  
 115 120 125

gaa acc gaa gct gaa aat gaa gcg ggc aaa act gaa gaa gtt tgc gca 432  
 Glu Thr Glu Ala Glu Asn Glu Ala Gly Lys Thr Glu Glu Val Cys Ala  
 130 135 140

cgt cag atc gac gcg gta ctg aaa act cag ggt gct gcg gca ttc gaa 480  
 Arg Gln Ile Asp Ala Val Leu Lys Thr Gln Gly Ala Ala Ala Phe Glu  
 145 150 155 160

ggt gcg gtt atc gct tac gaa cct gta tgg gca atc ggt act ggc aaa 528  
 Gly Ala Val Ile Ala Tyr Glu Pro Val Trp Ala Ile Gly Thr Gly Lys  
 165 170 175

tct gca act ccg gct cag gca cag gct gtt cac aaa ttc atc cgt gac 576



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Ser Ala Thr Pro Ala Gln Ala Gln Ala Val His Lys Phe Ile Arg Asp
      180                      185                      190
cac atc gct aaa gtt gac gct aac atc gct gaa caa gtg atc att cag      624
His Ile Ala Lys Val Asp Ala Asn Ile Ala Glu Gln Val Ile Ile Gln
      195                      200                      205

tac ggc ggc tct gta aac gcg tct aac gct gca gaa ctg ttt gct cag      672
Tyr Gly Gly Ser Val Asn Ala Ser Asn Ala Ala Glu Leu Phe Ala Gln
      210                      215                      220

ccg gat atc gac ggc gcg ctg gtt ggt ggt gct tct ctg aaa gct gac      720
Pro Asp Ile Asp Gly Ala Leu Val Gly Gly Ala Ser Leu Lys Ala Asp
      225                      230                      235                      240

gcc ttc gca gta atc gtt aaa gct gca gaa gcg gct aaa cag gct taa      768
Ala Phe Ala Val Ile Val Lys Ala Ala Glu Ala Ala Lys Gln Ala
      245                      250                      255

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<210> SEQ ID NO 19
<211> LENGTH: 255
<212> TYPE: PRT
<213> ORGANISM: Escherichia coli

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<400> SEQUENCE: 19

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Met Arg His Pro Leu Val Met Gly Asn Trp Lys Leu Asn Gly Ser Arg
 1          5          10
His Met Val His Glu Leu Val Ser Asn Leu Arg Lys Glu Leu Ala Gly
 20          25          30
Val Ala Gly Cys Ala Val Ala Ile Ala Pro Pro Glu Met Tyr Ile Asp
 35          40          45
Met Ala Lys Arg Glu Ala Glu Gly Ser His Ile Met Leu Gly Ala Gln
 50          55          60
Asn Val Asp Leu Asn Leu Ser Gly Ala Phe Thr Gly Glu Thr Ser Ala
 65          70          75          80
Ala Met Leu Lys Asp Ile Gly Ala Gln Tyr Ile Ile Ile Gly His Ser
 85          90          95
Glu Arg Arg Thr Tyr His Lys Glu Ser Asp Glu Leu Ile Ala Lys Lys
100         105         110
Phe Ala Val Leu Lys Glu Gln Gly Leu Thr Pro Val Leu Cys Ile Gly
115         120         125
Glu Thr Glu Ala Glu Asn Glu Ala Gly Lys Thr Glu Glu Val Cys Ala
130         135         140
Arg Gln Ile Asp Ala Val Leu Lys Thr Gln Gly Ala Ala Ala Phe Glu
145         150         155         160
Gly Ala Val Ile Ala Tyr Glu Pro Val Trp Ala Ile Gly Thr Gly Lys
165         170         175
Ser Ala Thr Pro Ala Gln Ala Gln Ala Val His Lys Phe Ile Arg Asp
180         185         190
His Ile Ala Lys Val Asp Ala Asn Ile Ala Glu Gln Val Ile Ile Gln
195         200         205
Tyr Gly Gly Ser Val Asn Ala Ser Asn Ala Ala Glu Leu Phe Ala Gln
210         215         220
Pro Asp Ile Asp Gly Ala Leu Val Gly Gly Ala Ser Leu Lys Ala Asp
225         230         235         240
Ala Phe Ala Val Ile Val Lys Ala Ala Glu Ala Ala Lys Gln Ala
245         250         255

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<210> SEQ ID NO 20
<211> LENGTH: 1080
<212> TYPE: DNA
<213> ORGANISM: Escherichia coli

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&lt;220&gt; FEATURE:

&lt;221&gt; NAME/KEY: CDS

&lt;222&gt; LOCATION: (1)..(1080)

&lt;400&gt; SEQUENCE: 20

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atg tct aag att ttt gat ttc gta aaa cct ggc gta atc act ggt gat      48
Met Ser Lys Ile Phe Asp Phe Val Lys Pro Gly Val Ile Thr Gly Asp
1           5           10           15

gac gta cag aaa gtt ttc cag gta gca aaa gaa aac aac ttc gca ctg      96
Asp Val Gln Lys Val Phe Gln Val Ala Lys Glu Asn Asn Phe Ala Leu
          20           25           30

cca gca gta aac tgc gtc ggt act gac tcc atc aac gcc gta ctg gaa      144
Pro Ala Val Asn Cys Val Gly Thr Asp Ser Ile Asn Ala Val Leu Glu
          35           40           45

acc gct gct aaa gtt aaa gcg ccg gtt atc gtt cag ttc tcc aac ggt      192
Thr Ala Ala Lys Val Lys Ala Pro Val Ile Val Gln Phe Ser Asn Gly
          50           55           60

ggt gct tcc ttt atc gct ggt aaa ggc gtg aaa tct gac gtt ccg cag      240
Gly Ala Ser Phe Ile Ala Gly Lys Gly Val Lys Ser Asp Val Pro Gln
65           70           75           80

ggt gct gct atc ctg ggc gcg atc tct ggt gcg cat cac gtt cac cag      288
Gly Ala Ala Ile Leu Gly Ala Ile Ser Gly Ala His His Val His Gln
          85           90           95

atg gct gaa cat tat ggt gtt ccg gtt atc ctg cac act gac cac tgc      336
Met Ala Glu His Tyr Gly Val Pro Val Ile Leu His Thr Asp His Cys
          100          105          110

gcg aag aaa ctg ctg ccg tgg atc gac ggt ctg ttg gac gcg ggt gaa      384
Ala Lys Lys Leu Leu Pro Trp Ile Asp Gly Leu Leu Asp Ala Gly Glu
          115          120          125

aaa cac ttc gca gct acc ggt aag ccg ctg ttc tct tct cac atg atc      432
Lys His Phe Ala Ala Thr Gly Lys Pro Leu Phe Ser Ser His Met Ile
          130          135          140

gac ctg tct gaa gaa tct ctg caa gag aac atc gaa atc tgc tct aaa      480
Asp Leu Ser Glu Glu Ser Leu Gln Glu Asn Ile Glu Ile Cys Ser Lys
145          150          155          160

tac ctg gag cgc atg tcc aaa atc ggc atg act ctg gaa atc gaa ctg      528
Tyr Leu Glu Arg Met Ser Lys Ile Gly Met Thr Leu Glu Ile Glu Leu
          165          170          175

ggt tgc acc ggt ggt gaa gaa gac ggc gtg gac aac agc cac atg gac      576
Gly Cys Thr Gly Gly Glu Glu Asp Gly Val Asp Asn Ser His Met Asp
          180          185          190

gct tct gca ctg tac acc cag ccg gaa gac gtt gat tac gca tac acc      624
Ala Ser Ala Leu Tyr Thr Gln Pro Glu Asp Val Asp Tyr Ala Tyr Thr
          195          200          205

gaa ctg agc aaa atc agc ccg cgt ttc acc atc gca gcg tcc ttc ggt      672
Glu Leu Ser Lys Ile Ser Pro Arg Phe Thr Ile Ala Ala Ser Phe Gly
          210          215          220

aac gta cac ggt gtt tac aag ccg ggt aac gtg gtt ctg act ccg acc      720
Asn Val His Gly Val Tyr Lys Pro Gly Asn Val Val Leu Thr Pro Thr
225          230          235          240

atc ctg cgt gat tct cag gaa tat gtt tcc aag aaa cac aac ctg ccg      768
Ile Leu Arg Asp Ser Gln Glu Tyr Val Ser Lys Lys His Asn Leu Pro
          245          250          255

cac aac agc ctg aac ttc gta ttc cac ggt ggt tcc ggt tct act gct      816
His Asn Ser Leu Asn Phe Val Phe His Gly Gly Ser Gly Ser Thr Ala
          260          265          270

cag gaa atc aaa gac tcc gta agc tac ggc gta gta aaa atg aac atc      864
Gln Glu Ile Lys Asp Ser Val Ser Tyr Gly Val Val Lys Met Asn Ile
          275          280          285

gat acc gat acc caa tgg gca acc tgg gaa ggc gtt ctg aac tac tac      912
Asp Thr Asp Thr Gln Trp Ala Thr Trp Glu Gly Val Leu Asn Tyr Tyr

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290	295	300	
aaa gcg aac gaa gct tat ctg cag ggt cag ctg ggt aac ccg aaa ggc			960
Lys Ala Asn Glu Ala Tyr Leu Gln Gly Gln Leu Gly Asn Pro Lys Gly			
305	310	315	320
gaa gat cag ccg aac aag aaa tac tac gat ccg cgc gta tgg ctg cgt			1008
Glu Asp Gln Pro Asn Lys Lys Tyr Tyr Asp Pro Arg Val Trp Leu Arg			
	325	330	335
gcc ggt cag act tcg atg atc gct cgt ctg gag aaa gca ttc cag gaa			1056
Ala Gly Gln Thr Ser Met Ile Ala Arg Leu Glu Lys Ala Phe Gln Glu			
	340	345	350
ctg aac gcg atc gac gtt ctg taa			1080
Leu Asn Ala Ile Asp Val Leu			
	355		
<210> SEQ ID NO 21			
<211> LENGTH: 359			
<212> TYPE: PRT			
<213> ORGANISM: Escherichia coli			
<400> SEQUENCE: 21			
Met Ser Lys Ile Phe Asp Phe Val Lys Pro Gly Val Ile Thr Gly Asp			
1	5	10	15
Asp Val Gln Lys Val Phe Gln Val Ala Lys Glu Asn Asn Phe Ala Leu			
	20	25	30
Pro Ala Val Asn Cys Val Gly Thr Asp Ser Ile Asn Ala Val Leu Glu			
	35	40	45
Thr Ala Ala Lys Val Lys Ala Pro Val Ile Val Gln Phe Ser Asn Gly			
	50	55	60
Gly Ala Ser Phe Ile Ala Gly Lys Gly Val Lys Ser Asp Val Pro Gln			
65	70	75	80
Gly Ala Ala Ile Leu Gly Ala Ile Ser Gly Ala His His Val His Gln			
	85	90	95
Met Ala Glu His Tyr Gly Val Pro Val Ile Leu His Thr Asp His Cys			
	100	105	110
Ala Lys Lys Leu Leu Pro Trp Ile Asp Gly Leu Leu Asp Ala Gly Glu			
	115	120	125
Lys His Phe Ala Ala Thr Gly Lys Pro Leu Phe Ser Ser His Met Ile			
	130	135	140
Asp Leu Ser Glu Glu Ser Leu Gln Glu Asn Ile Glu Ile Cys Ser Lys			
145	150	155	160
Tyr Leu Glu Arg Met Ser Lys Ile Gly Met Thr Leu Glu Ile Glu Leu			
	165	170	175
Gly Cys Thr Gly Gly Glu Glu Asp Gly Val Asp Asn Ser His Met Asp			
	180	185	190
Ala Ser Ala Leu Tyr Thr Gln Pro Glu Asp Val Asp Tyr Ala Tyr Thr			
	195	200	205
Glu Leu Ser Lys Ile Ser Pro Arg Phe Thr Ile Ala Ala Ser Phe Gly			
	210	215	220
Asn Val His Gly Val Tyr Lys Pro Gly Asn Val Val Leu Thr Pro Thr			
225	230	235	240
Ile Leu Arg Asp Ser Gln Glu Tyr Val Ser Lys Lys His Asn Leu Pro			
	245	250	255
His Asn Ser Leu Asn Phe Val Phe His Gly Gly Ser Gly Ser Thr Ala			
	260	265	270
Gln Glu Ile Lys Asp Ser Val Ser Tyr Gly Val Val Lys Met Asn Ile			
	275	280	285



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Asp Thr Asp Thr Gln Trp Ala Thr Trp Glu Gly Val Leu Asn Tyr Tyr  
 290 295 300  
 Lys Ala Asn Glu Ala Tyr Leu Gln Gly Gln Leu Gly Asn Pro Lys Gly  
 305 310 315 320  
 Glu Asp Gln Pro Asn Lys Lys Tyr Tyr Asp Pro Arg Val Trp Leu Arg  
 325 330 335  
 Ala Gly Gln Thr Ser Met Ile Ala Arg Leu Glu Lys Ala Phe Gln Glu  
 340 345 350  
 Leu Asn Ala Ile Asp Val Leu  
 355

<210> SEQ ID NO 22  
 <211> LENGTH: 1011  
 <212> TYPE: DNA  
 <213> ORGANISM: Escherichia coli  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1011)

<400> SEQUENCE: 22

atg aga cga gaa ctt gcc atc gaa ttt tcc cgc gtc acc gaa tca gcg 48  
 Met Arg Arg Glu Leu Ala Ile Glu Phe Ser Arg Val Thr Glu Ser Ala  
 1 5 10 15  
 gcg ctg gct ggc tac aaa tgg tta gga cgc ggc gat aaa aac acc gcg 96  
 Ala Leu Ala Gly Tyr Lys Trp Leu Gly Arg Gly Asp Lys Asn Thr Ala  
 20 25 30  
 gac ggc gcg gcg gta aac gcc atg cgt att atg ctc aac cag gtc aac 144  
 Asp Gly Ala Ala Val Asn Ala Met Arg Ile Met Leu Asn Gln Val Asn  
 35 40 45  
 att gac ggc acc atc gtc att ggt gaa ggt gaa atc gac gaa gca ccg 192  
 Ile Asp Gly Thr Ile Val Ile Gly Glu Gly Glu Ile Asp Glu Ala Pro  
 50 55 60  
 atg ctc tac att ggt gaa aaa gtc ggt act ggt cgc ggc gac gcg gta 240  
 Met Leu Tyr Ile Gly Glu Lys Val Gly Thr Gly Arg Gly Asp Ala Val  
 65 70 75 80  
 gat att gct gtt gat ccg att gaa ggc acg cgc atg acg gcg atg ggc 288  
 Asp Ile Ala Val Asp Pro Ile Glu Gly Thr Arg Met Thr Ala Met Gly  
 85 90 95  
 cag gct aac gcg ctg gcg gtg ctg gca gta ggc gat aaa ggc tgc ttc 336  
 Gln Ala Asn Ala Leu Ala Val Leu Ala Val Gly Asp Lys Gly Cys Phe  
 100 105 110  
 ctc aat gcg ccg gat atg tat atg gag aag ctg att gtc ggg ccg gga 384  
 Leu Asn Ala Pro Asp Met Tyr Met Glu Lys Leu Ile Val Gly Pro Gly  
 115 120 125  
 gcc aaa ggc acc att gat ctg aac ctg ccg ctg gcg gat aac ctg cgc 432  
 Ala Lys Gly Thr Ile Asp Leu Asn Leu Pro Leu Ala Asp Asn Leu Arg  
 130 135 140  
 aat gta gcg gcg gcg ctc ggc aaa ccg ttg agc gaa ctg acg gta acg 480  
 Asn Val Ala Ala Ala Leu Gly Lys Pro Leu Ser Glu Leu Thr Val Thr  
 145 150 155 160  
 att ctg gct aaa cca cgc cac gat gcc gtt atc gct gaa atg cag caa 528  
 Ile Leu Ala Lys Pro Arg His Asp Ala Val Ile Ala Glu Met Gln Gln  
 165 170 175  
 ctc ggc gta cgc gta ttt gct att ccg gac ggc gac gtt gcg gcc tca 576  
 Leu Gly Val Arg Val Phe Ala Ile Pro Asp Gly Asp Val Ala Ala Ser  
 180 185 190  
 att ctc acc tgt atg cca gac agc gaa gtt gac gtg ctg tac ggt att 624  
 Ile Leu Thr Cys Met Pro Asp Ser Glu Val Asp Val Leu Tyr Gly Ile  
 195 200 205  
 ggt ggc gcg ccg gaa ggc gta gtt tct gcg gcg gtg atc cgc gca tta 672  
 Gly Gly Ala Pro Glu Gly Val Val Ser Ala Ala Val Ile Arg Ala Leu

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210	215	220	
gat ggc gac atg aac ggt cgt ctg ctg gcg cgt cat gac gtc aaa ggc			720
Asp Gly Asp Met Asn Gly Arg Leu Leu Ala Arg His Asp Val Lys Gly			
225	230	235	240
gac aac gaa gag aat cgt cgc att ggc gag cag gag ctg gca cgc tgc			768
Asp Asn Glu Glu Asn Arg Arg Ile Gly Glu Gln Glu Leu Ala Arg Cys			
	245	250	255
aaa gcg atg ggc atc gaa gcc ggt aaa gta ttg cgc ctg ggc gat atg			816
Lys Ala Met Gly Ile Glu Ala Gly Lys Val Leu Arg Leu Gly Asp Met			
	260	265	270
gcg cgc agc gat aac gtc atc ttc tct gcc acc ggt att acc aaa ggc			864
Ala Arg Ser Asp Asn Val Ile Phe Ser Ala Thr Gly Ile Thr Lys Gly			
	275	280	285
gat ctg ctg gaa ggc att agc cgc aaa ggc aat atc gcg act acc gaa			912
Asp Leu Leu Glu Gly Ile Ser Arg Lys Gly Asn Ile Ala Thr Thr Glu			
	290	295	300
acg ctg ctg atc cgc ggc aag tca cgc acc att cgc cgc att cag tcc			960
Thr Leu Leu Ile Arg Gly Lys Ser Arg Thr Ile Arg Arg Ile Gln Ser			
305	310	315	320
atc cac tat ctg gat cgc aaa gac ccg gaa atg cag gtg cac atc ctc			1008
Ile His Tyr Leu Asp Arg Lys Asp Pro Glu Met Gln Val His Ile Leu			
	325	330	335
tga			1011

<210> SEQ ID NO 23  
 <211> LENGTH: 336  
 <212> TYPE: PRT  
 <213> ORGANISM: Escherichia coli

<400> SEQUENCE: 23

Met Arg Arg Glu Leu Ala Ile Glu Phe Ser Arg Val Thr Glu Ser Ala	
1	5 10 15
Ala Leu Ala Gly Tyr Lys Trp Leu Gly Arg Gly Asp Lys Asn Thr Ala	
	20 25 30
Asp Gly Ala Ala Val Asn Ala Met Arg Ile Met Leu Asn Gln Val Asn	
	35 40 45
Ile Asp Gly Thr Ile Val Ile Gly Glu Gly Glu Ile Asp Glu Ala Pro	
	50 55 60
Met Leu Tyr Ile Gly Glu Lys Val Gly Thr Gly Arg Gly Asp Ala Val	
65	70 75 80
Asp Ile Ala Val Asp Pro Ile Glu Gly Thr Arg Met Thr Ala Met Gly	
	85 90 95
Gln Ala Asn Ala Leu Ala Val Leu Ala Val Gly Asp Lys Gly Cys Phe	
	100 105 110
Leu Asn Ala Pro Asp Met Tyr Met Glu Lys Leu Ile Val Gly Pro Gly	
	115 120 125
Ala Lys Gly Thr Ile Asp Leu Asn Leu Pro Leu Ala Asp Asn Leu Arg	
	130 135 140
Asn Val Ala Ala Ala Leu Gly Lys Pro Leu Ser Glu Leu Thr Val Thr	
145	150 155 160
Ile Leu Ala Lys Pro Arg His Asp Ala Val Ile Ala Glu Met Gln Gln	
	165 170 175
Leu Gly Val Arg Val Phe Ala Ile Pro Asp Gly Asp Val Ala Ala Ser	
	180 185 190
Ile Leu Thr Cys Met Pro Asp Ser Glu Val Asp Val Leu Tyr Gly Ile	
	195 200 205
Gly Gly Ala Pro Glu Gly Val Val Ser Ala Ala Val Ile Arg Ala Leu	



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210	215	220
Asp Gly Asp Met Asn Gly Arg Leu Leu Ala Arg His Asp Val Lys Gly 225 230 235 240		
Asp Asn Glu Glu Asn Arg Arg Ile Gly Glu Gln Glu Leu Ala Arg Cys 245 250 255		
Lys Ala Met Gly Ile Glu Ala Gly Lys Val Leu Arg Leu Gly Asp Met 260 265 270		
Ala Arg Ser Asp Asn Val Ile Phe Ser Ala Thr Gly Ile Thr Lys Gly 275 280 285		
Asp Leu Leu Glu Gly Ile Ser Arg Lys Gly Asn Ile Ala Thr Thr Glu 290 295 300		
Thr Leu Leu Ile Arg Gly Lys Ser Arg Thr Ile Arg Arg Ile Gln Ser 305 310 315 320		
Ile His Tyr Leu Asp Arg Lys Asp Pro Glu Met Gln Val His Ile Leu 325 330 335		

<210> SEQ ID NO 24  
 <211> LENGTH: 1509  
 <212> TYPE: DNA  
 <213> ORGANISM: Escherichia coli  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1509)

<400> SEQUENCE: 24

atg act gaa aaa aaa tat atc gtt gcg ctc gac cag ggc acc acc agc Met Thr Glu Lys Lys Tyr Ile Val Ala Leu Asp Gln Gly Thr Thr Ser 1 5 10 15	48
tcc cgc gcg gtc gta atg gat cac gat gcc aat atc att agc gtg tcg Ser Arg Ala Val Val Met Asp His Asp Ala Asn Ile Ile Ser Val Ser 20 25 30	96
cag cgc gaa ttt gag caa atc tac cca aaa cca ggt tgg gta gaa cac Gln Arg Glu Phe Glu Gln Ile Tyr Pro Lys Pro Gly Trp Val Glu His 35 40 45	144
gac cca atg gaa atc tgg gcc acc caa agc tcc acg ctg gta gaa gtg Asp Pro Met Glu Ile Trp Ala Thr Gln Ser Ser Thr Leu Val Glu Val 50 55 60	192
ctg gcg aaa gcc gat atc agt tcc gat caa att gca gct atc ggt att Leu Ala Lys Ala Asp Ile Ser Ser Asp Gln Ile Ala Ala Ile Gly Ile 65 70 75 80	240
acg aac cag cgt gaa acc act att gtc tgg gaa aaa gaa acc ggc aag Thr Asn Gln Arg Glu Thr Thr Ile Val Trp Glu Lys Glu Thr Gly Lys 85 90 95	288
cct atc tat aac gcc att gtc tgg cag tgc cgt cgt acc gca gaa atc Pro Ile Tyr Asn Ala Ile Val Trp Gln Cys Arg Arg Thr Ala Glu Ile 100 105 110	336
tgc gag cat tta aaa cgt gac ggt tta gaa gat tat atc cgc agc aat Cys Glu His Leu Lys Arg Asp Gly Leu Glu Asp Tyr Ile Arg Ser Asn 115 120 125	384
acc ggt ctg gtg att gac ccg tac ttt tct ggc acc aaa gtg aag tgg Thr Gly Leu Val Ile Asp Pro Tyr Phe Ser Gly Thr Lys Val Lys Trp 130 135 140	432
atc ctc gac cat gtg gaa ggc tct cgc gag cgt gca cgt cgt ggt gaa Ile Leu Asp His Val Glu Gly Ser Arg Glu Arg Ala Arg Arg Gly Glu 145 150 155 160	480
ttg ctg ttt ggt acg gtt gat acg tgg ctt atc tgg aaa atg act cag Leu Leu Phe Gly Thr Val Asp Thr Trp Leu Ile Trp Lys Met Thr Gln 165 170 175	528
ggc cgt gtc cat gtg acc gat tac acc aac gcc tct cgt acc atg ttg Gly Arg Val His Val Thr Asp Tyr Thr Asn Ala Ser Arg Thr Met Leu	576

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180	185	190	
ttc aac atc cat acc ctg gac tgg gac gac aaa atg ctg gaa gtg ctg Phe Asn Ile His Thr Leu Asp Trp Asp Asp Lys Met Leu Glu Val Leu 195 200 205			624
gat att ccg cgc gag atg ctg cca gaa gtg cgt cgt tct tcc gaa gta Asp Ile Pro Arg Glu Met Leu Pro Glu Val Arg Ser Ser Glu Val 210 215 220			672
tac ggt cag act aac att ggc ggc aaa ggc ggc acg cgt att cca atc Tyr Gly Gln Thr Asn Ile Gly Gly Lys Gly Gly Thr Arg Ile Pro Ile 225 230 235 240			720
tcc ggg atc gcc ggt gac cag cag gcc gcg ctg ttt ggt cag ttg tgc Ser Gly Ile Ala Gly Asp Gln Gln Ala Ala Leu Phe Gly Gln Leu Cys 245 250 255			768
gtg aaa gaa ggg atg gcg aag aac acc tat ggc act ggc tgc ttt atg Val Lys Glu Gly Met Ala Lys Asn Thr Tyr Gly Thr Gly Cys Phe Met 260 265 270			816
ctg atg aac act ggc gag aaa gcg gtg aaa tca gaa aac ggc ctg ctg Leu Met Asn Thr Gly Glu Lys Ala Val Lys Ser Glu Asn Gly Leu Leu 275 280 285			864
acc acc atc gcc tgc ggc ccg act ggc gaa gtg aac tat gcg ttg gaa Thr Thr Ile Ala Cys Gly Pro Thr Gly Glu Val Asn Tyr Ala Leu Glu 290 295 300			912
ggt gcg gtg ttt atg gca ggc gca tcc att cag tgg ctg cgc gat gaa Gly Ala Val Phe Met Ala Gly Ala Ser Ile Gln Trp Leu Arg Asp Glu 305 310 315 320			960
atg aag ttg att aac gac gcc tac gat tcc gaa tat ttc gcc acc aaa Met Lys Leu Ile Asn Asp Ala Tyr Asp Ser Glu Tyr Phe Ala Thr Lys 325 330 335			1008
gtg caa aac acc aat ggt gtg tat gtg gtt ccg gca ttt acc ggg ctg Val Gln Asn Thr Asn Gly Val Tyr Val Val Pro Ala Phe Thr Gly Leu 340 345 350			1056
ggt gcg ccg tac tgg gac ccg tat gcg cgc ggg gcg att ttc ggt ctg Gly Ala Pro Tyr Trp Asp Pro Tyr Ala Arg Gly Ala Ile Phe Gly Leu 355 360 365			1104
act cgt ggg gtg aac gct aac cac att ata cgc gcg acg ctg gag tct Thr Arg Gly Val Asn Ala Asn His Ile Ile Arg Ala Thr Leu Glu Ser 370 375 380			1152
att gct tat cag acg cgt gac gtg ctg gaa gcg atg cag gcc gac tct Ile Ala Tyr Gln Thr Arg Asp Val Leu Glu Ala Met Gln Ala Asp Ser 385 390 395 400			1200
ggt atc cgt ctg cac gcc ctg cgc gtg gat ggt ggc gca gta gca aac Gly Ile Arg Leu His Ala Leu Arg Val Asp Gly Gly Ala Val Ala Asn 405 410 415			1248
aat ttc ctg atg cag ttc cag tcc gat att ctc ggc acc cgc gtt gag Asn Phe Leu Met Gln Phe Gln Ser Asp Ile Leu Gly Thr Arg Val Glu 420 425 430			1296
cgc ccg gaa gtg cgc gaa gtc acc gca ttg ggt gcg gcc tat ctc gca Arg Pro Glu Val Arg Glu Val Thr Ala Leu Gly Ala Ala Tyr Leu Ala 435 440 445			1344
ggc ctg gcg gtt ggc ttc tgg cag aac ctc gac gag ctg caa gag aaa Gly Leu Ala Val Gly Phe Trp Gln Asn Leu Asp Glu Leu Gln Glu Lys 450 455 460			1392
gcg gtg att gag cgc gag ttc cgt cca ggc atc gaa acc act gag cgt Ala Val Ile Glu Arg Glu Phe Arg Pro Gly Ile Glu Thr Thr Glu Arg 465 470 475 480			1440
aat tac cgt tac gca ggc tgg aaa aaa gcg gtt aaa cgc gcg atg gcg Asn Tyr Arg Tyr Ala Gly Trp Lys Lys Ala Val Lys Arg Ala Met Ala 485 490 495			1488
tgg gaa gaa cac gac gaa taa Trp Glu Glu His Asp Glu			1509



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500

<210> SEQ ID NO 25  
 <211> LENGTH: 502  
 <212> TYPE: PRT  
 <213> ORGANISM: Escherichia coli  
  
 <400> SEQUENCE: 25  
  
 Met Thr Glu Lys Lys Tyr Ile Val Ala Leu Asp Gln Gly Thr Thr Ser  
 1 5 10 15  
  
 Ser Arg Ala Val Val Met Asp His Asp Ala Asn Ile Ile Ser Val Ser  
 20 25 30  
  
 Gln Arg Glu Phe Glu Gln Ile Tyr Pro Lys Pro Gly Trp Val Glu His  
 35 40 45  
  
 Asp Pro Met Glu Ile Trp Ala Thr Gln Ser Ser Thr Leu Val Glu Val  
 50 55 60  
  
 Leu Ala Lys Ala Asp Ile Ser Ser Asp Gln Ile Ala Ala Ile Gly Ile  
 65 70 75 80  
  
 Thr Asn Gln Arg Glu Thr Thr Ile Val Trp Glu Lys Glu Thr Gly Lys  
 85 90 95  
  
 Pro Ile Tyr Asn Ala Ile Val Trp Gln Cys Arg Arg Thr Ala Glu Ile  
 100 105 110  
  
 Cys Glu His Leu Lys Arg Asp Gly Leu Glu Asp Tyr Ile Arg Ser Asn  
 115 120 125  
  
 Thr Gly Leu Val Ile Asp Pro Tyr Phe Ser Gly Thr Lys Val Lys Trp  
 130 135 140  
  
 Ile Leu Asp His Val Glu Gly Ser Arg Glu Arg Ala Arg Arg Gly Glu  
 145 150 155 160  
  
 Leu Leu Phe Gly Thr Val Asp Thr Trp Leu Ile Trp Lys Met Thr Gln  
 165 170 175  
  
 Gly Arg Val His Val Thr Asp Tyr Thr Asn Ala Ser Arg Thr Met Leu  
 180 185 190  
  
 Phe Asn Ile His Thr Leu Asp Trp Asp Asp Lys Met Leu Glu Val Leu  
 195 200 205  
  
 Asp Ile Pro Arg Glu Met Leu Pro Glu Val Arg Arg Ser Ser Glu Val  
 210 215 220  
  
 Tyr Gly Gln Thr Asn Ile Gly Gly Lys Gly Gly Thr Arg Ile Pro Ile  
 225 230 235 240  
  
 Ser Gly Ile Ala Gly Asp Gln Gln Ala Ala Leu Phe Gly Gln Leu Cys  
 245 250 255  
  
 Val Lys Glu Gly Met Ala Lys Asn Thr Tyr Gly Thr Gly Cys Phe Met  
 260 265 270  
  
 Leu Met Asn Thr Gly Glu Lys Ala Val Lys Ser Glu Asn Gly Leu Leu  
 275 280 285  
  
 Thr Thr Ile Ala Cys Gly Pro Thr Gly Glu Val Asn Tyr Ala Leu Glu  
 290 295 300  
  
 Gly Ala Val Phe Met Ala Gly Ala Ser Ile Gln Trp Leu Arg Asp Glu  
 305 310 315 320  
  
 Met Lys Leu Ile Asn Asp Ala Tyr Asp Ser Glu Tyr Phe Ala Thr Lys  
 325 330 335  
  
 Val Gln Asn Thr Asn Gly Val Tyr Val Val Pro Ala Phe Thr Gly Leu  
 340 345 350  
  
 Gly Ala Pro Tyr Trp Asp Pro Tyr Ala Arg Gly Ala Ile Phe Gly Leu  
 355 360 365  
  
 Thr Arg Gly Val Asn Ala Asn His Ile Ile Arg Ala Thr Leu Glu Ser

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370				375				380							
Ile	Ala	Tyr	Gln	Thr	Arg	Asp	Val	Leu	Glu	Ala	Met	Gln	Ala	Asp	Ser
385					390					395					400
Gly	Ile	Arg	Leu	His	Ala	Leu	Arg	Val	Asp	Gly	Gly	Ala	Val	Ala	Asn
				405					410					415	
Asn	Phe	Leu	Met	Gln	Phe	Gln	Ser	Asp	Ile	Leu	Gly	Thr	Arg	Val	Glu
			420					425					430		
Arg	Pro	Glu	Val	Arg	Glu	Val	Thr	Ala	Leu	Gly	Ala	Ala	Tyr	Leu	Ala
		435					440					445			
Gly	Leu	Ala	Val	Gly	Phe	Trp	Gln	Asn	Leu	Asp	Glu	Leu	Gln	Glu	Lys
	450					455					460				
Ala	Val	Ile	Glu	Arg	Glu	Phe	Arg	Pro	Gly	Ile	Glu	Thr	Thr	Glu	Arg
465					470					475					480
Asn	Tyr	Arg	Tyr	Ala	Gly	Trp	Lys	Lys	Ala	Val	Lys	Arg	Ala	Met	Ala
				485					490					495	
Trp	Glu	Glu	His	Asp	Glu										
			500												

<210> SEQ ID NO 26  
 <211> LENGTH: 1629  
 <212> TYPE: DNA  
 <213> ORGANISM: Escherichia coli  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1629)

<400> SEQUENCE: 26

atg	aaa	act	cgc	gac	tcg	caa	tca	agt	gac	gtg	att	atc	att	ggc	ggc	48
Met	Lys	Thr	Arg	Asp	Ser	Gln	Ser	Ser	Asp	Val	Ile	Ile	Ile	Gly	Gly	
1				5					10					15		
ggc	gca	acg	gga	gcc	ggg	att	gcc	cgc	gac	tgt	gcc	ctg	cgc	ggg	ctg	96
Gly	Ala	Thr	Gly	Ala	Gly	Ile	Ala	Arg	Asp	Cys	Ala	Leu	Arg	Gly	Leu	
			20					25					30			
cgc	gtg	att	ttg	ggt	gag	cgc	cac	gac	atc	gca	acc	ggt	gcc	acc	ggg	144
Arg	Val	Ile	Leu	Val	Glu	Arg	His	Asp	Ile	Ala	Thr	Gly	Ala	Thr	Gly	
		35					40					45				
cgt	aac	cac	ggc	ctg	ctg	cac	agc	ggt	gcg	cgc	tat	gcg	gta	acc	gat	192
Arg	Asn	His	Gly	Leu	Leu	His	Ser	Gly	Ala	Arg	Tyr	Ala	Val	Thr	Asp	
	50					55					60					
gcg	gaa	tcg	gcc	cgc	gaa	tgc	att	agt	gaa	aac	cag	atc	ctg	aaa	cgc	240
Ala	Glu	Ser	Ala	Arg	Glu	Cys	Ile	Ser	Glu	Asn	Gln	Ile	Leu	Lys	Arg	
65					70					75					80	
att	gca	cgt	cac	tgc	ggt	gaa	cca	acc	aac	ggc	ctg	ttt	atc	acc	ctg	288
Ile	Ala	Arg	His	Cys	Val	Glu	Pro	Thr	Asn	Gly	Leu	Phe	Ile	Thr	Leu	
			85						90					95		
ccg	gaa	gat	gac	ctc	tcc	ttc	cag	gcc	act	ttt	att	cgc	gcc	tgc	gaa	336
Pro	Glu	Asp	Asp	Leu	Ser	Phe	Gln	Ala	Thr	Phe	Ile	Arg	Ala	Cys	Glu	
			100					105					110			
gaa	gca	ggg	atc	agc	gca	gaa	gct	ata	gac	ccg	cag	caa	gcg	cgc	att	384
Glu	Ala	Gly	Ile	Ser	Ala	Glu	Ala	Ile	Asp	Pro	Gln	Gln	Ala	Arg	Ile	
		115					120					125				
atc	gaa	cct	gcc	ggt	aac	ccg	gca	ctg	att	ggc	gcg	gtg	aaa	ggt	ccg	432
Ile	Glu	Pro	Ala	Val	Asn	Pro	Ala	Leu	Ile	Gly	Ala	Val	Lys	Val	Pro	
	130					135						140				
gat	ggc	acc	ggt	gat	cca	ttt	cgt	ctg	acc	gca	gca	aac	atg	ctg	gat	480
Asp	Gly	Thr	Val	Asp	Pro	Phe	Arg	Leu	Thr	Ala	Ala	Asn	Met	Leu	Asp	
145					150					155				160		
gcc	aaa	gaa	cac	ggt	gcc	ggt	atc	ctt	acc	gct	cat	gaa	gtc	acg	ggg	528
Ala	Lys	Glu	His	Gly	Ala	Val	Ile	Leu	Thr	Ala	His	Glu	Val	Thr	Gly	
				165						170				175		



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ctg att cgt gaa ggc gcg acg gtg tgc ggt gtt cgt gta cgt aac cat	576
Leu Ile Arg Glu Gly Ala Thr Val Cys Gly Val Arg Val Arg Asn His	
180 185 190	
ctc acc ggc gaa act cag gcc ctt cat gca cct gtc gtg gtt aat gcc	624
Leu Thr Gly Glu Thr Gln Ala Leu His Ala Pro Val Val Val Asn Ala	
195 200 205	
gct ggg atc tgg ggg caa cac att gcc gaa tat gcc gat ctg cgc att	672
Ala Gly Ile Trp Gly Gln His Ile Ala Glu Tyr Ala Asp Leu Arg Ile	
210 215 220	
cgc atg ttc ccg gcg aaa gga tgc ctg ctg atc atg gat cac cgc att	720
Arg Met Phe Pro Ala Lys Gly Ser Leu Leu Ile Met Asp His Arg Ile	
225 230 235 240	
aac cag cat gtg atc aac cgc tgc cgt aaa cct tcc gac gcc gat att	768
Asn Gln His Val Ile Asn Arg Cys Arg Lys Pro Ser Asp Ala Asp Ile	
245 250 255	
ctg gtg cct ggc gat acc att tgc ctg att ggt acc acc tct tta cgt	816
Leu Val Pro Gly Asp Thr Ile Ser Leu Ile Gly Thr Thr Ser Leu Arg	
260 265 270	
att gat tac aac gag att gac gat aat cga gtg acg gca gaa gag gtt	864
Ile Asp Tyr Asn Glu Ile Asp Asp Asn Arg Val Thr Ala Glu Glu Val	
275 280 285	
gat att ctg ctg cgt gaa ggg gaa aaa ctg gcc ccc gtg atg gcg aaa	912
Asp Ile Leu Leu Arg Glu Gly Glu Lys Leu Ala Pro Val Met Ala Lys	
290 295 300	
acg cgc att ttg cgg gcc tat tct ggc gtg cgc ccg ctg gtt gcc agc	960
Thr Arg Ile Leu Arg Ala Tyr Ser Gly Val Arg Pro Leu Val Ala Ser	
305 310 315 320	
gat gac gac ccg agc gga cgt aac gtc agc cgt ggc atc gtg ctg ctc	1008
Asp Asp Asp Pro Ser Gly Arg Asn Val Ser Arg Gly Ile Val Leu Leu	
325 330 335	
gac cat gct gaa cgc gat ggt ctg gac gga ttt atc acc atc acc ggt	1056
Asp His Ala Glu Arg Asp Gly Leu Asp Gly Phe Ile Thr Ile Thr Gly	
340 345 350	
ggc aaa ctg atg acc tat cgg ctg atg gct gaa tgg gct acc gac gcg	1104
Gly Lys Leu Met Thr Tyr Arg Leu Met Ala Glu Trp Ala Thr Asp Ala	
355 360 365	
gta tgc cgc aaa ctg ggc aac acg cgc ccc tgt acg act gcc gat ctg	1152
Val Cys Arg Lys Leu Gly Asn Thr Arg Pro Cys Thr Thr Ala Asp Leu	
370 375 380	
gca ctg cct ggt tca caa gaa ccc gct gaa gtt acc ttg cgt aaa gtc	1200
Ala Leu Pro Gly Ser Gln Glu Pro Ala Glu Val Thr Leu Arg Lys Val	
385 390 395 400	
atc tcc ctg cct gcc ccg ctg cgc ggt tct gcg gtt tat cgt cat ggc	1248
Ile Ser Leu Pro Ala Pro Leu Arg Gly Ser Ala Val Tyr Arg His Gly	
405 410 415	
gat cgc acg cct gcc tgg ctg agc gaa ggc cgt ctg cac cgt agc ctg	1296
Asp Arg Thr Pro Ala Trp Leu Ser Glu Gly Arg Leu His Arg Ser Leu	
420 425 430	
gta tgt gag tgc gaa gcg gta act gcg ggt gaa gtg cag tac gcg gta	1344
Val Cys Glu Cys Glu Ala Val Thr Ala Gly Glu Val Gln Tyr Ala Val	
435 440 445	
gaa aat tta aac gtt aat agc ctg ctg gat tta cgc cgt cgt acc cgt	1392
Glu Asn Leu Asn Val Asn Ser Leu Leu Asp Leu Arg Arg Arg Thr Arg	
450 455 460	
gtg ggg atg ggc acc tgc cag ggc gaa ctc tgc gcc tgc cgc gct gcc	1440
Val Gly Met Gly Thr Cys Gln Gly Glu Leu Cys Ala Cys Arg Ala Ala	
465 470 475 480	
gga ctg ctg caa cgt ttt aac gtc acg acg tcc gcg caa tct atc gag	1488
Gly Leu Leu Gln Arg Phe Asn Val Thr Thr Ser Ala Gln Ser Ile Glu	
485 490 495	

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caa ctt tcc acc ttc ctt aac gaa cgc tgg aaa ggc gtg caa ccc atc      1536
Gln Leu Ser Thr Phe Leu Asn Glu Arg Trp Lys Gly Val Gln Pro Ile
          500                      505                      510

gcc tgg gga gat gca ctg cgc gaa agc gaa ttt acc cgc tgg gtt tat      1584
Ala Trp Gly Asp Ala Leu Arg Glu Ser Glu Phe Thr Arg Trp Val Tyr
          515                      520                      525

cag gga ttg tgt ggt ctg gag aag gag cag aaa gat gcg ctt tga      1629
Gln Gly Leu Cys Gly Leu Glu Lys Glu Gln Lys Asp Ala Leu
          530                      535                      540

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<210> SEQ ID NO 27
<211> LENGTH: 542
<212> TYPE: PRT
<213> ORGANISM: Escherichia coli

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<400> SEQUENCE: 27

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Met Lys Thr Arg Asp Ser Gln Ser Ser Asp Val Ile Ile Ile Gly Gly
1          5          10          15

Gly Ala Thr Gly Ala Gly Ile Ala Arg Asp Cys Ala Leu Arg Gly Leu
          20          25          30

Arg Val Ile Leu Val Glu Arg His Asp Ile Ala Thr Gly Ala Thr Gly
          35          40          45

Arg Asn His Gly Leu Leu His Ser Gly Ala Arg Tyr Ala Val Thr Asp
          50          55          60

Ala Glu Ser Ala Arg Glu Cys Ile Ser Glu Asn Gln Ile Leu Lys Arg
          65          70          75          80

Ile Ala Arg His Cys Val Glu Pro Thr Asn Gly Leu Phe Ile Thr Leu
          85          90          95

Pro Glu Asp Asp Leu Ser Phe Gln Ala Thr Phe Ile Arg Ala Cys Glu
          100         105         110

Glu Ala Gly Ile Ser Ala Glu Ala Ile Asp Pro Gln Gln Ala Arg Ile
          115         120         125

Ile Glu Pro Ala Val Asn Pro Ala Leu Ile Gly Ala Val Lys Val Pro
          130         135         140

Asp Gly Thr Val Asp Pro Phe Arg Leu Thr Ala Ala Asn Met Leu Asp
          145         150         155         160

Ala Lys Glu His Gly Ala Val Ile Leu Thr Ala His Glu Val Thr Gly
          165         170         175

Leu Ile Arg Glu Gly Ala Thr Val Cys Gly Val Arg Val Arg Asn His
          180         185         190

Leu Thr Gly Glu Thr Gln Ala Leu His Ala Pro Val Val Val Asn Ala
          195         200         205

Ala Gly Ile Trp Gly Gln His Ile Ala Glu Tyr Ala Asp Leu Arg Ile
          210         215         220

Arg Met Phe Pro Ala Lys Gly Ser Leu Leu Ile Met Asp His Arg Ile
          225         230         235         240

Asn Gln His Val Ile Asn Arg Cys Arg Lys Pro Ser Asp Ala Asp Ile
          245         250         255

Leu Val Pro Gly Asp Thr Ile Ser Leu Ile Gly Thr Thr Ser Leu Arg
          260         265         270

Ile Asp Tyr Asn Glu Ile Asp Asp Asn Arg Val Thr Ala Glu Glu Val
          275         280         285

Asp Ile Leu Leu Arg Glu Gly Glu Lys Leu Ala Pro Val Met Ala Lys
          290         295         300

Thr Arg Ile Leu Arg Ala Tyr Ser Gly Val Arg Pro Leu Val Ala Ser
          305         310         315         320

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Asp Asp Asp Pro Ser Gly Arg Asn Val Ser Arg Gly Ile Val Leu Leu  
                   325                                  330                                  335  
 Asp His Ala Glu Arg Asp Gly Leu Asp Gly Phe Ile Thr Ile Thr Gly  
                   340                                  345                                  350  
 Gly Lys Leu Met Thr Tyr Arg Leu Met Ala Glu Trp Ala Thr Asp Ala  
                   355                                  360                                  365  
 Val Cys Arg Lys Leu Gly Asn Thr Arg Pro Cys Thr Thr Ala Asp Leu  
                   370                                  375                                  380  
 Ala Leu Pro Gly Ser Gln Glu Pro Ala Glu Val Thr Leu Arg Lys Val  
                   385                                  390                                  395                                  400  
 Ile Ser Leu Pro Ala Pro Leu Arg Gly Ser Ala Val Tyr Arg His Gly  
                   405                                  410                                  415  
 Asp Arg Thr Pro Ala Trp Leu Ser Glu Gly Arg Leu His Arg Ser Leu  
                   420                                  425                                  430  
 Val Cys Glu Cys Glu Ala Val Thr Ala Gly Glu Val Gln Tyr Ala Val  
                   435                                  440                                  445  
 Glu Asn Leu Asn Val Asn Ser Leu Leu Asp Leu Arg Arg Arg Thr Arg  
                   450                                  455                                  460  
 Val Gly Met Gly Thr Cys Gln Gly Glu Leu Cys Ala Cys Arg Ala Ala  
                   465                                  470                                  475                                  480  
 Gly Leu Leu Gln Arg Phe Asn Val Thr Thr Ser Ala Gln Ser Ile Glu  
                   485                                  490                                  495  
 Gln Leu Ser Thr Phe Leu Asn Glu Arg Trp Lys Gly Val Gln Pro Ile  
                   500                                  505                                  510  
 Ala Trp Gly Asp Ala Leu Arg Glu Ser Glu Phe Thr Arg Trp Val Tyr  
                   515                                  520                                  525  
 Gln Gly Leu Cys Gly Leu Glu Lys Glu Gln Lys Asp Ala Leu  
                   530                                  535                                  540

<210> SEQ ID NO 28  
 <211> LENGTH: 1260  
 <212> TYPE: DNA  
 <213> ORGANISM: Escherichia coli  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1260)

<400> SEQUENCE: 28

atg cgc ttt gat act gtc att atg ggc ggc ggc ctc gcc gga tta ctc           48  
 Met Arg Phe Asp Thr Val Ile Met Gly Gly Gly Leu Ala Gly Leu Leu  
 1                  5                                  10                                  15  
 tgt ggc ctg caa ctg caa aaa cac ggc ctg cgc tgt gcc att gtc act           96  
 Cys Gly Leu Gln Leu Gln Lys His Gly Leu Arg Cys Ala Ile Val Thr  
                   20                                  25                                  30  
 cgt ggt caa agc gca ctg cat ttc tca tcc gga tcg ctg gat ttg ctg           144  
 Arg Gly Gln Ser Ala Leu His Phe Ser Ser Gly Ser Leu Asp Leu Leu  
                   35                                  40                                  45  
 agc cat ctg cca gat ggt caa ccg gtg aca gac att cac agt gga ctg           192  
 Ser His Leu Pro Asp Gly Gln Pro Val Thr Asp Ile His Ser Gly Leu  
                   50                                  55                                  60  
 gaa tct ttg cgt cag cag gca cca gcc cat cct tac tcc ctt ctc gag           240  
 Glu Ser Leu Arg Gln Gln Ala Pro Ala His Pro Tyr Ser Leu Leu Glu  
                   65                                  70                                  75                                  80  
 cca caa cgc gtg ctc gat ctc gct tgc cag gcg cag gca tta atc gct           288  
 Pro Gln Arg Val Leu Asp Leu Ala Cys Gln Ala Gln Ala Leu Ile Ala  
                   85                                  90                                  95  
 gaa agc ggt gcg caa ttg cag ggc agc gta gaa ctt gct cac cag cgg           336  
 Glu Ser Gly Ala Gln Leu Gln Gly Ser Val Glu Leu Ala His Gln Arg

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100	105	110	
ggt acg ccg ctc ggc act ctg cgc tct acc tgg cta agt tcg cca gaa Val Thr Pro Leu Gly Thr Leu Arg Ser Thr Trp Leu Ser Ser Pro Glu 115	120	125	384
gtc ccc gtc tgg ccg ctg ccc gcg aag aaa ata tgt gta gtg gga att Val Pro Val Trp Pro Leu Pro Ala Lys Lys Ile Cys Val Val Gly Ile 130	135	140	432
agc ggc ctg atg gat ttt cag gcg cac ctt gcg gca gct tcg ttg cgt Ser Gly Leu Met Asp Phe Gln Ala His Leu Ala Ala Ala Ser Leu Arg 145	150	155	480
gaa ctc ggc ctt gcc gtt gaa acc gca gaa ata gag ctg ccg gaa ctg Glu Leu Gly Leu Ala Val Glu Thr Ala Glu Ile Glu Leu Pro Glu Leu 165	170	175	528
gat gtg ctg cgc aat aac gcc acc gaa ttt cgc gcg gtg aat atc gcc Asp Val Leu Arg Asn Asn Ala Thr Glu Phe Arg Ala Val Asn Ile Ala 180	185	190	576
cgt ttc ctt gat aat gaa gaa aac tgg ccg ctg tta ctt gat gcg ctt Arg Phe Leu Asp Asn Glu Glu Asn Trp Pro Leu Leu Leu Asp Ala Leu 195	200	205	624
att cct gtc gcc aat acc tgc gaa atg atc ctg atg ccc gcc tgc ttc Ile Pro Val Ala Asn Thr Cys Glu Met Ile Leu Met Pro Ala Cys Phe 210	215	220	672
ggt ctg gcc gat gac aaa ctg tgg cgt tgg ttg aat gaa aaa cta cct Gly Leu Ala Asp Asp Lys Leu Trp Arg Trp Leu Asn Glu Lys Leu Pro 225	230	235	720
tgt tca ctg atg ctt ttg cca acg ctg ccg cct tcc gtg ctg ggc att Cys Ser Leu Met Leu Leu Pro Thr Leu Pro Pro Ser Val Leu Gly Ile 245	250	255	768
cgt ctg caa aac cag tta cag cgc cag ttt gtg cgc cag ggt ggc gtg Arg Leu Gln Asn Gln Leu Gln Arg Gln Phe Val Arg Gln Gly Gly Val 260	265	270	816
tgg atg ccg ggc gat gaa gtg aaa aaa gtg acc tgt aaa aat ggc gta Trp Met Pro Gly Asp Glu Val Lys Lys Val Thr Cys Lys Asn Gly Val 275	280	285	864
gtg aac gaa atc tgg acc cgc aat cac gcc gat att ccg cta cgt cca Val Asn Glu Ile Trp Thr Arg Asn His Ala Asp Ile Pro Leu Arg Pro 290	295	300	912
cgt ttc gcg gtt ctc gcc agc ggc agt ttc ttt agt ggc gga ctg gta Arg Phe Ala Val Leu Ala Ser Gly Ser Phe Phe Ser Gly Gly Leu Val 305	310	315	960
gcg gaa cgt aac ggc att cga gag ccg att ctc ggc ctt gat gtg cta Ala Glu Arg Asn Gly Ile Arg Glu Pro Ile Leu Gly Leu Asp Val Leu 325	330	335	1008
caa acc gcc acg cgg ggt gaa tgg tat aag gga gat ttt ttt gcg ccg Gln Thr Ala Thr Arg Gly Glu Trp Tyr Lys Gly Asp Phe Phe Ala Pro 340	345	350	1056
caa ccg tgg cag cag ttc ggt gta acc act gat gag acg cta cgc ccg Gln Pro Trp Gln Gln Phe Gly Val Thr Thr Asp Glu Thr Leu Arg Pro 355	360	365	1104
tca cag gca ggg caa acc att gaa aac ctg ttt gcc atc ggt tcg gtg Ser Gln Ala Gly Gln Thr Ile Glu Asn Leu Phe Ala Ile Gly Ser Val 370	375	380	1152
ctg ggc gga ttt gat ccc atc gcc cag gga tgc ggc ggc ggt gtt tgt Leu Gly Gly Phe Asp Pro Ile Ala Gln Gly Cys Gly Gly Gly Val Cys 385	390	395	1200
gcc gtc agt gct tta cat gcc gct caa cag att gcc caa cgc gca gga Ala Val Ser Ala Leu His Ala Ala Gln Gln Ile Ala Gln Arg Ala Gly 405	410	415	1248
ggc caa caa tga Gly Gln Gln			1260



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<210> SEQ ID NO 29  
 <211> LENGTH: 419  
 <212> TYPE: PRT  
 <213> ORGANISM: Escherichia coli  
  
 <400> SEQUENCE: 29  
  
 Met Arg Phe Asp Thr Val Ile Met Gly Gly Gly Leu Ala Gly Leu Leu  
 1 5 10 15  
  
 Cys Gly Leu Gln Leu Gln Lys His Gly Leu Arg Cys Ala Ile Val Thr  
 20 25 30  
  
 Arg Gly Gln Ser Ala Leu His Phe Ser Ser Gly Ser Leu Asp Leu Leu  
 35 40 45  
  
 Ser His Leu Pro Asp Gly Gln Pro Val Thr Asp Ile His Ser Gly Leu  
 50 55 60  
  
 Glu Ser Leu Arg Gln Gln Ala Pro Ala His Pro Tyr Ser Leu Leu Glu  
 65 70 75 80  
  
 Pro Gln Arg Val Leu Asp Leu Ala Cys Gln Ala Gln Ala Leu Ile Ala  
 85 90 95  
  
 Glu Ser Gly Ala Gln Leu Gln Gly Ser Val Glu Leu Ala His Gln Arg  
 100 105 110  
  
 Val Thr Pro Leu Gly Thr Leu Arg Ser Thr Trp Leu Ser Ser Pro Glu  
 115 120 125  
  
 Val Pro Val Trp Pro Leu Pro Ala Lys Lys Ile Cys Val Val Gly Ile  
 130 135 140  
  
 Ser Gly Leu Met Asp Phe Gln Ala His Leu Ala Ala Ala Ser Leu Arg  
 145 150 155 160  
  
 Glu Leu Gly Leu Ala Val Glu Thr Ala Glu Ile Glu Leu Pro Glu Leu  
 165 170 175  
  
 Asp Val Leu Arg Asn Asn Ala Thr Glu Phe Arg Ala Val Asn Ile Ala  
 180 185 190  
  
 Arg Phe Leu Asp Asn Glu Glu Asn Trp Pro Leu Leu Leu Asp Ala Leu  
 195 200 205  
  
 Ile Pro Val Ala Asn Thr Cys Glu Met Ile Leu Met Pro Ala Cys Phe  
 210 215 220  
  
 Gly Leu Ala Asp Asp Lys Leu Trp Arg Trp Leu Asn Glu Lys Leu Pro  
 225 230 235 240  
  
 Cys Ser Leu Met Leu Leu Pro Thr Leu Pro Pro Ser Val Leu Gly Ile  
 245 250 255  
  
 Arg Leu Gln Asn Gln Leu Gln Arg Gln Phe Val Arg Gln Gly Gly Val  
 260 265 270  
  
 Trp Met Pro Gly Asp Glu Val Lys Lys Val Thr Cys Lys Asn Gly Val  
 275 280 285  
  
 Val Asn Glu Ile Trp Thr Arg Asn His Ala Asp Ile Pro Leu Arg Pro  
 290 295 300  
  
 Arg Phe Ala Val Leu Ala Ser Gly Ser Phe Phe Ser Gly Gly Leu Val  
 305 310 315 320  
  
 Ala Glu Arg Asn Gly Ile Arg Glu Pro Ile Leu Gly Leu Asp Val Leu  
 325 330 335  
  
 Gln Thr Ala Thr Arg Gly Glu Trp Tyr Lys Gly Asp Phe Phe Ala Pro  
 340 345 350  
  
 Gln Pro Trp Gln Gln Phe Gly Val Thr Thr Asp Glu Thr Leu Arg Pro  
 355 360 365  
  
 Ser Gln Ala Gly Gln Thr Ile Glu Asn Leu Phe Ala Ile Gly Ser Val  
 370 375 380

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Leu Gly Gly Phe Asp Pro Ile Ala Gln Gly Cys Gly Gly Gly Val Cys  
385 390 395 400

Ala Val Ser Ala Leu His Ala Ala Gln Gln Ile Ala Gln Arg Ala Gly  
405 410 415

Gly Gln Gln

<210> SEQ ID NO 30

<211> LENGTH: 1191

<212> TYPE: DNA

<213> ORGANISM: Escherichia coli

<220> FEATURE:

<221> NAME/KEY: CDS

<222> LOCATION: (1)..(1191)

<400> SEQUENCE: 30

atg aat gac acc agc ttc gaa aac tgc att aag tgc acc gtc tgc acc 48  
Met Asn Asp Thr Ser Phe Glu Asn Cys Ile Lys Cys Thr Val Cys Thr  
1 5 10 15

acc gcc tgc ccg gtg agc cgg gtg aat ccc ggt tat cca ggg cca aaa 96  
Thr Ala Cys Pro Val Ser Arg Val Asn Pro Gly Tyr Pro Gly Pro Lys  
20 25 30

caa gcc ggg ccg gat ggc gag cgt ctg cgt ttg aaa gat ggc gca ctg 144  
Gln Ala Gly Pro Asp Gly Glu Arg Leu Arg Leu Lys Asp Gly Ala Leu  
35 40 45

tat gac gag gcg ctg aaa tat tgc atc aac tgc aaa cgt tgt gaa gtc 192  
Tyr Asp Glu Ala Leu Lys Tyr Cys Ile Asn Cys Lys Arg Cys Glu Val  
50 55 60

gcc tgc ccg tcc gat gtg aag att ggc gat att atc cag cgc gcg cgg 240  
Ala Cys Pro Ser Asp Val Lys Ile Gly Asp Ile Ile Gln Arg Ala Arg  
65 70 75 80

gcg aaa tat gac acc acg cgc ccg tcg ctg cgt aat ttt gtg ttg agt 288  
Ala Lys Tyr Asp Thr Thr Arg Pro Ser Leu Arg Asn Phe Val Leu Ser  
85 90 95

cat acc gac ctg atg ggt agc gtt tcc acg ccg ttc gca cca atc gtc 336  
His Thr Asp Leu Met Gly Ser Val Ser Thr Pro Phe Ala Pro Ile Val  
100 105 110

aac acc gct acc tcg ctg aaa ccg gtg cgg cag ctg ctt gat gcg gcg 384  
Asn Thr Ala Thr Ser Leu Lys Pro Val Arg Gln Leu Leu Asp Ala Ala  
115 120 125

tta aaa atc gat cat cgc cgc acg cta ccg aaa tac tcc ttc ggc acg 432  
Leu Lys Ile Asp His Arg Arg Thr Leu Pro Lys Tyr Ser Phe Gly Thr  
130 135 140

ttc cgt cgc tgg tat cgc agc gtg gcg gct cag caa gca caa tat aaa 480  
Phe Arg Arg Trp Tyr Arg Ser Val Ala Ala Gln Gln Ala Gln Tyr Lys  
145 150 155 160

gac cag gtc gct ttc ttt cac ggc tgc ttc gtt aac tac aac cat ccg 528  
Asp Gln Val Ala Phe Phe His Gly Cys Phe Val Asn Tyr Asn His Pro  
165 170 175

cag tta ggt aaa gat tta att aaa gtg ctc aac gca atg ggt acc ggt 576  
Gln Leu Gly Lys Asp Leu Ile Lys Val Leu Asn Ala Met Gly Thr Gly  
180 185 190

gta caa ctg ctc agc aaa gaa aaa tgc tgc ggc gta ccg cta atc gcc 624  
Val Gln Leu Leu Ser Lys Glu Lys Cys Cys Gly Val Pro Leu Ile Ala  
195 200 205

aac ggc ttt acc gat aaa gca cgc aaa cag gca att acg aat gta gag 672  
Asn Gly Phe Thr Asp Lys Ala Arg Lys Gln Ala Ile Thr Asn Val Glu  
210 215 220

tcg atc cgc gaa gct gtg gga gta aaa ggc att ccg gtg att gcc acc 720  
Ser Ile Arg Glu Ala Val Gly Val Lys Gly Ile Pro Val Ile Ala Thr  
225 230 235 240



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tcc tca acc tgt aca ttt gcc ctg cgc gac gaa tac ccg gaa gtg ctg	768
Ser Ser Thr Cys Thr Phe Ala Leu Arg Asp Glu Tyr Pro Glu Val Leu	
245 250 255	
aat gtc gac aac aaa ggc ttg cgc gat cat atc gaa ctg gca acc cgc	816
Asn Val Asp Asn Lys Gly Leu Arg Asp His Ile Glu Leu Ala Thr Arg	
260 265 270	
tgg ctg tgg cgc aag ctg gac gaa ggc aaa acg tta ccg ctg aaa ccg	864
Trp Leu Trp Arg Lys Leu Asp Glu Gly Lys Thr Leu Pro Leu Lys Pro	
275 280 285	
ctg ccg ctg aaa gtg gtt tat cac act ccg tgc cat atg gaa aaa atg	912
Leu Pro Leu Lys Val Val Tyr His Thr Pro Cys His Met Glu Lys Met	
290 295 300	
ggc tgg acg ctc tac acc ctg gag ctg ttg cgt aac atc ccg ggg ctt	960
Gly Trp Thr Leu Tyr Thr Leu Glu Leu Leu Arg Asn Ile Pro Gly Leu	
305 310 315 320	
gag tta acg gtg ctg gat tcc cag tgc tgc ggt att gcg ggt act tac	1008
Glu Leu Thr Val Leu Asp Ser Gln Cys Cys Gly Ile Ala Gly Thr Tyr	
325 330 335	
ggt ttc aaa aaa gag aac tac ccc acc tca caa gcc atc ggc gca cca	1056
Gly Phe Lys Lys Glu Asn Tyr Pro Thr Ser Gln Ala Ile Gly Ala Pro	
340 345 350	
ctg ttc cgc cag ata gaa gaa agc ggc gca gat ctg gtg gtc acc gac	1104
Leu Phe Arg Gln Ile Glu Glu Ser Gly Ala Asp Leu Val Val Thr Asp	
355 360 365	
tgc gaa acc tgt aaa tgg cag att gag atg tcc aca agt ctt cgc tgc	1152
Cys Glu Thr Cys Lys Trp Gln Ile Glu Met Ser Thr Ser Leu Arg Cys	
370 375 380	
gaa cat ccg att acg cta ctg gcc cag gcg ctg gct taa	1191
Glu His Pro Ile Thr Leu Leu Ala Gln Ala Leu Ala	
385 390 395	

&lt;210&gt; SEQ ID NO 31

&lt;211&gt; LENGTH: 396

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Escherichia coli

&lt;400&gt; SEQUENCE: 31

Met Asn Asp Thr Ser Phe Glu Asn Cys Ile Lys Cys Thr Val Cys Thr	
1 5 10 15	
Thr Ala Cys Pro Val Ser Arg Val Asn Pro Gly Tyr Pro Gly Pro Lys	
20 25 30	
Gln Ala Gly Pro Asp Gly Glu Arg Leu Arg Leu Lys Asp Gly Ala Leu	
35 40 45	
Tyr Asp Glu Ala Leu Lys Tyr Cys Ile Asn Cys Lys Arg Cys Glu Val	
50 55 60	
Ala Cys Pro Ser Asp Val Lys Ile Gly Asp Ile Ile Gln Arg Ala Arg	
65 70 75 80	
Ala Lys Tyr Asp Thr Thr Arg Pro Ser Leu Arg Asn Phe Val Leu Ser	
85 90 95	
His Thr Asp Leu Met Gly Ser Val Ser Thr Pro Phe Ala Pro Ile Val	
100 105 110	
Asn Thr Ala Thr Ser Leu Lys Pro Val Arg Gln Leu Leu Asp Ala Ala	
115 120 125	
Leu Lys Ile Asp His Arg Arg Thr Leu Pro Lys Tyr Ser Phe Gly Thr	
130 135 140	
Phe Arg Arg Trp Tyr Arg Ser Val Ala Ala Gln Gln Ala Gln Tyr Lys	
145 150 155 160	
Asp Gln Val Ala Phe Phe His Gly Cys Phe Val Asn Tyr Asn His Pro	
165 170 175	

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Gln Leu Gly Lys Asp Leu Ile Lys Val Leu Asn Ala Met Gly Thr Gly  
 180 185 190

Val Gln Leu Leu Ser Lys Glu Lys Cys Cys Gly Val Pro Leu Ile Ala  
 195 200 205

Asn Gly Phe Thr Asp Lys Ala Arg Lys Gln Ala Ile Thr Asn Val Glu  
 210 215 220

Ser Ile Arg Glu Ala Val Gly Val Lys Gly Ile Pro Val Ile Ala Thr  
 225 230 235 240

Ser Ser Thr Cys Thr Phe Ala Leu Arg Asp Glu Tyr Pro Glu Val Leu  
 245 250 255

Asn Val Asp Asn Lys Gly Leu Arg Asp His Ile Glu Leu Ala Thr Arg  
 260 265 270

Trp Leu Trp Arg Lys Leu Asp Glu Gly Lys Thr Leu Pro Leu Lys Pro  
 275 280 285

Leu Pro Leu Lys Val Val Tyr His Thr Pro Cys His Met Glu Lys Met  
 290 295 300

Gly Trp Thr Leu Tyr Thr Leu Glu Leu Leu Arg Asn Ile Pro Gly Leu  
 305 310 315 320

Glu Leu Thr Val Leu Asp Ser Gln Cys Cys Gly Ile Ala Gly Thr Tyr  
 325 330 335

Gly Phe Lys Lys Glu Asn Tyr Pro Thr Ser Gln Ala Ile Gly Ala Pro  
 340 345 350

Leu Phe Arg Gln Ile Glu Glu Ser Gly Ala Asp Leu Val Val Thr Asp  
 355 360 365

Cys Glu Thr Cys Lys Trp Gln Ile Glu Met Ser Thr Ser Leu Arg Cys  
 370 375 380

Glu His Pro Ile Thr Leu Leu Ala Gln Ala Leu Ala  
 385 390 395

<210> SEQ ID NO 32  
 <211> LENGTH: 1506  
 <212> TYPE: DNA  
 <213> ORGANISM: Escherichia coli  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1506)

<400> SEQUENCE: 32

atg gaa acc aaa gat ctg att gtg ata ggg ggc ggc atc aat ggt gct 48  
 Met Glu Thr Lys Asp Leu Ile Val Ile Gly Gly Gly Ile Asn Gly Ala  
 1 5 10 15

ggt atc gcg gca gac gcc gct gga cgc ggt tta tcc gtg ctg atg ctg 96  
 Gly Ile Ala Ala Asp Ala Ala Gly Arg Gly Leu Ser Val Leu Met Leu  
 20 25 30

gag gcg cag gat ctc gct tgc gcg acc tct tcc gcc agt tca aaa ctc 144  
 Glu Ala Gln Asp Leu Ala Cys Ala Thr Ser Ser Ala Ser Ser Lys Leu  
 35 40 45

att cac ggt ggc ctg cgc tac ctt gag cac tat gaa ttc cgc ctg gtc 192  
 Ile His Gly Gly Leu Arg Tyr Leu Glu His Tyr Glu Phe Arg Leu Val  
 50 55 60

agc gag gcg ctg gct gaa cgt gaa gtg ctg ctg aaa atg gcc ccg cat 240  
 Ser Glu Ala Leu Ala Glu Arg Glu Val Leu Leu Lys Met Ala Pro His  
 65 70 75 80

atc gcc ttc ccg atg cgt ttt cgc ctg cca cat cgt ccg cat ctg cgc 288  
 Ile Ala Phe Pro Met Arg Phe Arg Leu Pro His Arg Pro His Leu Arg  
 85 90 95

ccg gcg tgg atg att cgc att ggt ctg ttt atg tac gat cat ctg ggt 336  
 Pro Ala Trp Met Ile Arg Ile Gly Leu Phe Met Tyr Asp His Leu Gly



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100	105	110	
aaa cgc acc agc ttg ccg gga tca act ggt ttg cgt ttt ggc gca aat Lys Arg Thr Ser Leu Pro Gly Ser Thr Gly Leu Arg Phe Gly Ala Asn 115 120 125			384
tca gtg tta aaa ccg gaa att aag cgc gga ttc gaa tat tct gac tgt Ser Val Leu Lys Pro Glu Ile Lys Arg Gly Phe Glu Tyr Ser Asp Cys 130 135 140			432
tgg gta gac gac gcc cgt ctg gta ctc gcc aac gcc cag atg gtg gtg Trp Val Asp Asp Ala Arg Leu Val Leu Ala Asn Ala Gln Met Val Val 145 150 155 160			480
cgt aaa ggc ggc gaa gtg ctt act cgg act cgc gcc acc tct gct cgc Arg Lys Gly Gly Glu Val Leu Thr Arg Thr Arg Ala Thr Ser Ala Arg 165 170 175			528
cgc gaa aac ggc ctg tgg att gtg gaa cgc gaa gat atc gat acc ggc Arg Glu Asn Gly Leu Trp Ile Val Glu Ala Glu Asp Ile Asp Thr Gly 180 185 190			576
aaa aaa tat agc tgg caa gcg cgc ggc ttg gtt aac gcc acc ggc ccg Lys Lys Tyr Ser Trp Gln Ala Arg Gly Leu Val Asn Ala Thr Gly Pro 195 200 205			624
tgg gtg aaa cag ttc ttc gac gac ggg atg cat ctg cct tcg cct tat Trp Val Lys Gln Phe Phe Asp Asp Gly Met His Leu Pro Ser Pro Tyr 210 215 220			672
ggc att cgc ctg atc aaa ggc agc cat att gtg gtg ccg cgc gtg cat Gly Ile Arg Leu Ile Lys Gly Ser His Ile Val Val Pro Arg Val His 225 230 235 240			720
acc cag aag caa gcc tac att ctg caa aac gaa gat aaa cgt att gtg Thr Gln Lys Gln Ala Tyr Ile Leu Gln Asn Glu Asp Lys Arg Ile Val 245 250 255			768
ttc gtg atc ccg tgg atg gac gag ttt tcc atc atc ggc act acc gat Phe Val Ile Pro Trp Met Asp Glu Phe Ser Ile Ile Gly Thr Thr Asp 260 265 270			816
gtc gag tac aaa ggc gat ccg aaa gcg gtg aag att gaa gag agt gaa Val Glu Tyr Lys Gly Asp Pro Lys Ala Val Lys Ile Glu Glu Ser Glu 275 280 285			864
atc aat tac ctg ctg aat gtg tat aac acg cac ttt aaa aag cag tta Ile Asn Tyr Leu Leu Asn Val Tyr Asn Thr His Phe Lys Lys Gln Leu 290 295 300			912
agc cgt gac gat atc gtc tgg acc tac tcc ggt gtg cgt ccg ctg tgt Ser Arg Asp Asp Ile Val Trp Thr Tyr Ser Gly Val Arg Pro Leu Cys 305 310 315 320			960
gat gat gag tcc gac tcg ccg cag gct att acc cgt gat tac acc ctt Asp Asp Glu Ser Asp Ser Pro Gln Ala Ile Thr Arg Asp Tyr Thr Leu 325 330 335			1008
gat att cat gat gaa aat ggc aaa gca ccg ctg ctg tcg gta ttc ggc Asp Ile His Asp Glu Asn Gly Lys Ala Pro Leu Leu Ser Val Phe Gly 340 345 350			1056
ggt aag ctg acc acc tac cga aaa ctg gcg gaa cat gcg ctg gaa aaa Gly Lys Leu Thr Thr Tyr Arg Lys Leu Ala Glu His Ala Leu Glu Lys 355 360 365			1104
cta acg ccg tat tat cag ggt att ggc ccg gca tgg acg aaa gag agt Leu Thr Pro Tyr Tyr Gln Gly Ile Gly Pro Ala Trp Thr Lys Glu Ser 370 375 380			1152
gtg cta ccg ggt ggc gcc att gaa ggc gac cgc gac gat tat gcc gct Val Leu Pro Gly Gly Ala Ile Glu Gly Asp Arg Asp Asp Tyr Ala Ala 385 390 395 400			1200
cgc ctg cgc cgc cgc tat ccg ttc ctg act gaa tcg ctg gcg cgt cat Arg Leu Arg Arg Arg Tyr Pro Phe Leu Thr Glu Ser Leu Ala Arg His 405 410 415			1248
tac gct cgc act tac ggc agc aac agc gag ctg ctg ctc ggc aat gcg Tyr Ala Arg Thr Tyr Gly Ser Asn Ser Glu Leu Leu Leu Gly Asn Ala			1296

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420	425	430	
gga acg gta agc gat ctc ggg gaa gat ttc ggt cat gag ttc tac gaa			1344
Gly Thr Val Ser Asp Leu Gly Glu Asp Phe Gly His Glu Phe Tyr Glu			
435	440	445	
gcg gag ctg aaa tac ctg gtg gat cac gaa tgg gtc cgc cgc gcc gac			1392
Ala Glu Leu Lys Tyr Leu Val Asp His Glu Trp Val Arg Arg Ala Asp			
450	455	460	
gac gcc ctg tgg cgt cgc aca aaa caa ggc atg tgg cta aat gcg gat			1440
Asp Ala Leu Trp Arg Arg Thr Lys Gln Gly Met Trp Leu Asn Ala Asp			
465	470	475	480
caa caa tct cgt gtg agt cag tgg ctg gtg gag tat acg cag cag agg			1488
Gln Gln Ser Arg Val Ser Gln Trp Leu Val Glu Tyr Thr Gln Gln Arg			
485	490	495	
tta tcg ctg gcg tcg taa			1506
Leu Ser Leu Ala Ser			
500			

&lt;210&gt; SEQ ID NO 33

&lt;211&gt; LENGTH: 501

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Escherichia coli

&lt;400&gt; SEQUENCE: 33

Met Glu Thr Lys Asp Leu Ile Val Ile Gly Gly Gly Ile Asn Gly Ala			
1	5	10	15
Gly Ile Ala Ala Asp Ala Ala Gly Arg Gly Leu Ser Val Leu Met Leu			
20	25	30	
Glu Ala Gln Asp Leu Ala Cys Ala Thr Ser Ser Ala Ser Ser Lys Leu			
35	40	45	
Ile His Gly Gly Leu Arg Tyr Leu Glu His Tyr Glu Phe Arg Leu Val			
50	55	60	
Ser Glu Ala Leu Ala Glu Arg Glu Val Leu Leu Lys Met Ala Pro His			
65	70	75	80
Ile Ala Phe Pro Met Arg Phe Arg Leu Pro His Arg Pro His Leu Arg			
85	90	95	
Pro Ala Trp Met Ile Arg Ile Gly Leu Phe Met Tyr Asp His Leu Gly			
100	105	110	
Lys Arg Thr Ser Leu Pro Gly Ser Thr Gly Leu Arg Phe Gly Ala Asn			
115	120	125	
Ser Val Leu Lys Pro Glu Ile Lys Arg Gly Phe Glu Tyr Ser Asp Cys			
130	135	140	
Trp Val Asp Asp Ala Arg Leu Val Leu Ala Asn Ala Gln Met Val Val			
145	150	155	160
Arg Lys Gly Gly Glu Val Leu Thr Arg Thr Arg Ala Thr Ser Ala Arg			
165	170	175	
Arg Glu Asn Gly Leu Trp Ile Val Glu Ala Glu Asp Ile Asp Thr Gly			
180	185	190	
Lys Lys Tyr Ser Trp Gln Ala Arg Gly Leu Val Asn Ala Thr Gly Pro			
195	200	205	
Trp Val Lys Gln Phe Phe Asp Asp Gly Met His Leu Pro Ser Pro Tyr			
210	215	220	
Gly Ile Arg Leu Ile Lys Gly Ser His Ile Val Val Pro Arg Val His			
225	230	235	240
Thr Gln Lys Gln Ala Tyr Ile Leu Gln Asn Glu Asp Lys Arg Ile Val			
245	250	255	
Phe Val Ile Pro Trp Met Asp Glu Phe Ser Ile Ile Gly Thr Thr Asp			
260	265	270	



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Val Glu Tyr Lys Gly Asp Pro Lys Ala Val Lys Ile Glu Glu Ser Glu  
 275 280 285

Ile Asn Tyr Leu Leu Asn Val Tyr Asn Thr His Phe Lys Lys Gln Leu  
 290 295 300

Ser Arg Asp Asp Ile Val Trp Thr Tyr Ser Gly Val Arg Pro Leu Cys  
 305 310 315 320

Asp Asp Glu Ser Asp Ser Pro Gln Ala Ile Thr Arg Asp Tyr Thr Leu  
 325 330 335

Asp Ile His Asp Glu Asn Gly Lys Ala Pro Leu Leu Ser Val Phe Gly  
 340 345 350

Gly Lys Leu Thr Thr Tyr Arg Lys Leu Ala Glu His Ala Leu Glu Lys  
 355 360 365

Leu Thr Pro Tyr Tyr Gln Gly Ile Gly Pro Ala Trp Thr Lys Glu Ser  
 370 375 380

Val Leu Pro Gly Gly Ala Ile Glu Gly Asp Arg Asp Asp Tyr Ala Ala  
 385 390 395 400

Arg Leu Arg Arg Arg Tyr Pro Phe Leu Thr Glu Ser Leu Ala Arg His  
 405 410 415

Tyr Ala Arg Thr Tyr Gly Ser Asn Ser Glu Leu Leu Leu Gly Asn Ala  
 420 425 430

Gly Thr Val Ser Asp Leu Gly Glu Asp Phe Gly His Glu Phe Tyr Glu  
 435 440 445

Ala Glu Leu Lys Tyr Leu Val Asp His Glu Trp Val Arg Arg Ala Asp  
 450 455 460

Asp Ala Leu Trp Arg Arg Thr Lys Gln Gly Met Trp Leu Asn Ala Asp  
 465 470 475 480

Gln Gln Ser Arg Val Ser Gln Trp Leu Val Glu Tyr Thr Gln Gln Arg  
 485 490 495

Leu Ser Leu Ala Ser  
 500

<210> SEQ ID NO 34  
 <211> LENGTH: 1071  
 <212> TYPE: DNA  
 <213> ORGANISM: Escherichia coli  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1071)

<400> SEQUENCE: 34

atg aaa aaa ttg atc aat gat gtg caa gac gta ctg gac gaa caa ctg	48
Met Lys Lys Leu Ile Asn Asp Val Gln Asp Val Leu Asp Glu Gln Leu	
1 5 10 15	
gca gga ctg gcg aaa gcg cat cca tcg ctg aca ctg cat cag gat ccg	96
Ala Gly Leu Ala Lys Ala His Pro Ser Leu Thr Leu His Gln Asp Pro	
20 25 30	
gtg tat gtc acc cga gct gat gcc cct gtt gca gga aaa gtc gcc ctg	144
Val Tyr Val Thr Arg Ala Asp Ala Pro Val Ala Gly Lys Val Ala Leu	
35 40 45	
ctg tcg ggt ggc ggc agc gga cac gag ccg atg cac tgt ggt tat atc	192
Leu Ser Gly Gly Gly Ser Gly His Glu Pro Met His Cys Gly Tyr Ile	
50 55 60	
ggt cag ggg atg ctt tcg ggg gcc tgt ccg ggc gaa att ttc acc tca	240
Gly Gln Gly Met Leu Ser Gly Ala Cys Pro Gly Glu Ile Phe Thr Ser	
65 70 75 80	
ccg acg ccc gat aaa atc ttt gaa tgc gcc atg caa gtt gat ggc ggc	288
Pro Thr Pro Asp Lys Ile Phe Glu Cys Ala Met Gln Val Asp Gly Gly	
85 90 95	

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gaa ggt gta ctg ttg att atc aaa aat tac acc ggc gat att ctt aac 336  
 Glu Gly Val Leu Leu Ile Ile Lys Asn Tyr Thr Gly Asp Ile Leu Asn  
                   100                  105                  110

ttt gaa aca gcg acc gag tta ctg cac gat agc ggc gta aaa gtg acc 384  
 Phe Glu Thr Ala Thr Glu Leu Leu His Asp Ser Gly Val Lys Val Thr  
                   115                  120                  125

act gtg gtc att gat gac gac gtt gcg gta aaa gac agt ctt tat act 432  
 Thr Val Val Ile Asp Asp Val Ala Val Lys Asp Ser Leu Tyr Thr  
                   130                  135                  140

gcc ggg cga cgc ggc gtt gcc aac acc gta tta att gaa aaa ctc gta 480  
 Ala Gly Arg Arg Gly Val Ala Asn Thr Val Leu Ile Glu Lys Leu Val  
                   145                  150                  155                  160

ggc gca gcg gcg gag cgt ggc gac tca ctg gac gcc tgt gcg gaa ctg 528  
 Gly Ala Ala Ala Glu Arg Gly Asp Ser Leu Asp Ala Cys Ala Glu Leu  
                   165                  170                  175

ggg cgt aag ctg aat aat caa ggc cac tca ata ggt atc gct ctc ggt 576  
 Gly Arg Lys Leu Asn Asn Gln Gly His Ser Ile Gly Ile Ala Leu Gly  
                   180                  185                  190

gcc tgt acc gtt cct gcc gcg ggc aaa cct tct ttt acc ctg gcg gat 624  
 Ala Cys Thr Val Pro Ala Ala Gly Lys Pro Ser Phe Thr Leu Ala Asp  
                   195                  200                  205

aat gag atg gag ttt ggc gtc ggc att cat ggt gag ccg ggt att gac 672  
 Asn Glu Met Glu Phe Gly Val Gly Ile His Gly Glu Pro Gly Ile Asp  
                   210                  215                  220

cgc cgc ccc ttc tct tcc ctt gat caa acc gtc gat gaa atg ttc gac 720  
 Arg Arg Pro Phe Ser Ser Leu Asp Gln Thr Val Asp Glu Met Phe Asp  
                   225                  230                  235                  240

acc ctg ctg gta aat ggc tca tac cat cgc act ttg cgt ttc tgg gat 768  
 Thr Leu Leu Val Asn Gly Ser Tyr His Arg Thr Leu Arg Phe Trp Asp  
                   245                  250                  255

tat caa caa ggc agt tgg cag gaa gaa caa caa acc aaa caa ccg ctc 816  
 Tyr Gln Gln Gly Ser Trp Gln Glu Glu Gln Gln Thr Lys Gln Pro Leu  
                   260                  265                  270

cag tct ggc gat cgg gtg att gcg ctg gtt aac aat ctt ggc gca act 864  
 Gln Ser Gly Asp Arg Val Ile Ala Leu Val Asn Asn Leu Gly Ala Thr  
                   275                  280                  285

ccg ctt tct gag ctg tac ggc gtc tat aac cgc ctg acc aca cgt tgc 912  
 Pro Leu Ser Glu Leu Tyr Gly Val Tyr Asn Arg Leu Thr Thr Arg Cys  
                   290                  295                  300

cag caa gcg gga ttg act atc gaa cgt aat tta att ggc gcg tac tgc 960  
 Gln Gln Ala Gly Leu Thr Ile Glu Arg Asn Leu Ile Gly Ala Tyr Cys  
                   305                  310                  315                  320

acc tca ctg gat atg acc ggt ttc tca atc acc tta ctg aaa gtt gat 1008  
 Thr Ser Leu Asp Met Thr Gly Phe Ser Ile Thr Leu Leu Lys Val Asp  
                   325                  330                  335

gac gaa acg ctg gca ctc tgg gac gcc ccg gtc cac acc ccg gcc ctt 1056  
 Asp Glu Thr Leu Ala Leu Trp Asp Ala Pro Val His Thr Pro Ala Leu  
                   340                  345                  350

aac tgg ggt aaa taa 1071  
 Asn Trp Gly Lys  
                   355

<210> SEQ ID NO 35  
 <211> LENGTH: 356  
 <212> TYPE: PRT  
 <213> ORGANISM: Escherichia coli

<400> SEQUENCE: 35

Met Lys Lys Leu Ile Asn Asp Val Gln Asp Val Leu Asp Glu Gln Leu  
 1                  5                  10                  15



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Ala Gly Leu Ala Lys Ala His Pro Ser Leu Thr Leu His Gln Asp Pro  
 20 25 30

Val Tyr Val Thr Arg Ala Asp Ala Pro Val Ala Gly Lys Val Ala Leu  
 35 40 45

Leu Ser Gly Gly Gly Ser Gly His Glu Pro Met His Cys Gly Tyr Ile  
 50 55 60

Gly Gln Gly Met Leu Ser Gly Ala Cys Pro Gly Glu Ile Phe Thr Ser  
 65 70 75 80

Pro Thr Pro Asp Lys Ile Phe Glu Cys Ala Met Gln Val Asp Gly Gly  
 85 90 95

Glu Gly Val Leu Leu Ile Ile Lys Asn Tyr Thr Gly Asp Ile Leu Asn  
 100 105 110

Phe Glu Thr Ala Thr Glu Leu Leu His Asp Ser Gly Val Lys Val Thr  
 115 120 125

Thr Val Val Ile Asp Asp Asp Val Ala Val Lys Asp Ser Leu Tyr Thr  
 130 135 140

Ala Gly Arg Arg Gly Val Ala Asn Thr Val Leu Ile Glu Lys Leu Val  
 145 150 155 160

Gly Ala Ala Ala Glu Arg Gly Asp Ser Leu Asp Ala Cys Ala Glu Leu  
 165 170 175

Gly Arg Lys Leu Asn Asn Gln Gly His Ser Ile Gly Ile Ala Leu Gly  
 180 185 190

Ala Cys Thr Val Pro Ala Ala Gly Lys Pro Ser Phe Thr Leu Ala Asp  
 195 200 205

Asn Glu Met Glu Phe Gly Val Gly Ile His Gly Glu Pro Gly Ile Asp  
 210 215 220

Arg Arg Pro Phe Ser Ser Leu Asp Gln Thr Val Asp Glu Met Phe Asp  
 225 230 235 240

Thr Leu Leu Val Asn Gly Ser Tyr His Arg Thr Leu Arg Phe Trp Asp  
 245 250 255

Tyr Gln Gln Gly Ser Trp Gln Glu Glu Gln Gln Thr Lys Gln Pro Leu  
 260 265 270

Gln Ser Gly Asp Arg Val Ile Ala Leu Val Asn Asn Leu Gly Ala Thr  
 275 280 285

Pro Leu Ser Glu Leu Tyr Gly Val Tyr Asn Arg Leu Thr Thr Arg Cys  
 290 295 300

Gln Gln Ala Gly Leu Thr Ile Glu Arg Asn Leu Ile Gly Ala Tyr Cys  
 305 310 315 320

Thr Ser Leu Asp Met Thr Gly Phe Ser Ile Thr Leu Leu Lys Val Asp  
 325 330 335

Asp Glu Thr Leu Ala Leu Trp Asp Ala Pro Val His Thr Pro Ala Leu  
 340 345 350

Asn Trp Gly Lys  
 355

<210> SEQ ID NO 36  
 <211> LENGTH: 633  
 <212> TYPE: DNA  
 <213> ORGANISM: Escherichia coli  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(633)

<400> SEQUENCE: 36

atg tca ctg agc aga act caa att gtt aac tgg ctc act cgt tgt ggc  
 Met Ser Leu Ser Arg Thr Gln Ile Val Asn Trp Leu Thr Arg Cys Gly  
 1 5 10 15

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gat att ttc agc acc gag agc gag tat ctt acc gga ctg gat cgc gaa      96
Asp Ile Phe Ser Thr Glu Ser Glu Tyr Leu Thr Gly Leu Asp Arg Glu
          20                      25                      30

att ggc gat gct gac cac ggg cta aat atg aac cga ggc ttt agc aaa      144
Ile Gly Asp Ala Asp His Gly Leu Asn Met Asn Arg Gly Phe Ser Lys
          35                      40                      45

gtg gtg gaa aaa ctc cct gct atc gca gat aaa gat atc ggt ttc att      192
Val Val Glu Lys Leu Pro Ala Ile Ala Asp Lys Asp Ile Gly Phe Ile
          50                      55                      60

ctc aag aat acc ggt atg acg ctg ctt tcc agc gtc ggt ggt gcc agt      240
Leu Lys Asn Thr Gly Met Thr Leu Leu Ser Ser Val Gly Gly Ala Ser
          65                      70                      75                      80

ggt ccg ctg ttc ggt acc ttc ttt atc cgc gcc gca cag gcg acc cag      288
Gly Pro Leu Phe Gly Thr Phe Phe Ile Arg Ala Ala Gln Ala Thr Gln
          85                      90                      95

gca cgg caa agc ctg aca ctg gaa gag ctt tat cag atg ttc cgc gat      336
Ala Arg Gln Ser Leu Thr Leu Glu Glu Leu Tyr Gln Met Phe Arg Asp
          100                      105                      110

ggc gcg gac ggc gta atc agt cgc ggg aaa gcc gaa cct ggc gat aaa      384
Gly Ala Asp Gly Val Ile Ser Arg Gly Lys Ala Glu Pro Gly Asp Lys
          115                      120                      125

acc atg tgt gat gtg tgg gtg ccg gtg gtg gaa tcg tta cgt cag tcc      432
Thr Met Cys Asp Val Trp Val Pro Val Val Glu Ser Leu Arg Gln Ser
          130                      135                      140

agc gag caa aat ctc tct gtt ccg gtg gcg ctc gaa gct gcc agt agc      480
Ser Glu Gln Asn Leu Ser Val Pro Val Ala Leu Glu Ala Ala Ser Ser
          145                      150                      155                      160

atc gcc gaa tcc gct gca caa agt acg att acg atg caa gcc cgc aaa      528
Ile Ala Glu Ser Ala Ala Gln Ser Thr Ile Thr Met Gln Ala Arg Lys
          165                      170                      175

ggc cgc gcc agt tat ctc ggt gaa cgc agt att ggt cac cag gat ccc      576
Gly Arg Ala Ser Tyr Leu Gly Glu Arg Ser Ile Gly His Gln Asp Pro
          180                      185                      190

ggc gcg acc tcg gtg atg ttt atg atg caa atg ttg gcg tta gcc gca      624
Gly Ala Thr Ser Val Met Phe Met Met Gln Met Leu Ala Leu Ala Ala
          195                      200                      205

aaa gag taa
Lys Glu
          210

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<210> SEQ ID NO 37
<211> LENGTH: 210
<212> TYPE: PRT
<213> ORGANISM: Escherichia coli

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<400> SEQUENCE: 37

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Met Ser Leu Ser Arg Thr Gln Ile Val Asn Trp Leu Thr Arg Cys Gly
1          5          10          15

Asp Ile Phe Ser Thr Glu Ser Glu Tyr Leu Thr Gly Leu Asp Arg Glu
          20          25          30

Ile Gly Asp Ala Asp His Gly Leu Asn Met Asn Arg Gly Phe Ser Lys
          35          40          45

Val Val Glu Lys Leu Pro Ala Ile Ala Asp Lys Asp Ile Gly Phe Ile
          50          55          60

Leu Lys Asn Thr Gly Met Thr Leu Leu Ser Ser Val Gly Gly Ala Ser
65          70          75          80

Gly Pro Leu Phe Gly Thr Phe Phe Ile Arg Ala Ala Gln Ala Thr Gln
          85          90          95

Ala Arg Gln Ser Leu Thr Leu Glu Glu Leu Tyr Gln Met Phe Arg Asp

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100				105				110							
Gly	Ala	Asp	Gly	Val	Ile	Ser	Arg	Gly	Lys	Ala	Glu	Pro	Gly	Asp	Lys
		115					120						125		
Thr	Met	Cys	Asp	Val	Trp	Val	Pro	Val	Val	Glu	Ser	Leu	Arg	Gln	Ser
	130					135					140				
Ser	Glu	Gln	Asn	Leu	Ser	Val	Pro	Val	Ala	Leu	Glu	Ala	Ala	Ser	Ser
145				150						155					160
Ile	Ala	Glu	Ser	Ala	Ala	Gln	Ser	Thr	Ile	Thr	Met	Gln	Ala	Arg	Lys
				165					170					175	
Gly	Arg	Ala	Ser	Tyr	Leu	Gly	Glu	Arg	Ser	Ile	Gly	His	Gln	Asp	Pro
		180						185					190		
Gly	Ala	Thr	Ser	Val	Met	Phe	Met	Met	Gln	Met	Leu	Ala	Leu	Ala	Ala
		195					200					205			
Lys	Glu														
	210														

<210> SEQ ID NO 38  
 <211> LENGTH: 1419  
 <212> TYPE: DNA  
 <213> ORGANISM: Escherichia coli  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1419)

<400> SEQUENCE: 38

atg gta aac ctg gtc ata gtt tca cat agc agc cga ctg gga gaa ggt	48
Met Val Asn Leu Val Ile Val Ser His Ser Ser Arg Leu Gly Glu Gly	
1 5 10 15	
gtc ggt gaa tta gcc cgt cag atg tta atg agt gat agt tgt aaa atc	96
Val Gly Glu Leu Ala Arg Gln Met Leu Met Ser Asp Ser Cys Lys Ile	
20 25 30	
gcc att gcc gcg gga att gac gat cca caa aat ccc att ggt acc gat	144
Ala Ile Ala Ala Gly Ile Asp Asp Pro Gln Asn Pro Ile Gly Thr Asp	
35 40 45	
gcc gtc aaa gtg atg gag gcc atc gaa tct gtt gct gat gcc gac cat	192
Ala Val Lys Val Met Glu Ala Ile Glu Ser Val Ala Asp Ala Asp His	
50 55 60	
gtg ctg gtc atg atg gat atg ggt agc gca tta ttg agt gct gaa act	240
Val Leu Val Met Met Asp Met Gly Ser Ala Leu Leu Ser Ala Glu Thr	
65 70 75 80	
gcg ctg gaa ttg ctg gct ccc gag atc gcc gca aaa gta cgt ttg tgt	288
Ala Leu Glu Leu Leu Ala Pro Glu Ile Ala Ala Lys Val Arg Leu Cys	
85 90 95	
gct gcg ccg ttg gtc gaa ggt aca ctg gca gca acg gtc agc gcg gcc	336
Ala Ala Pro Leu Val Glu Gly Thr Leu Ala Ala Thr Val Ser Ala Ala	
100 105 110	
tcg ggg gcg gat atc gac aaa gtt atc ttt gac gcc atg cat gcg ctg	384
Ser Gly Ala Asp Ile Asp Lys Val Ile Phe Asp Ala Met His Ala Leu	
115 120 125	
gaa gcc aaa cgt gaa caa ctg ggt tta ccg tcc tcc gac act gaa atc	432
Glu Ala Lys Arg Glu Gln Leu Gly Leu Pro Ser Ser Asp Thr Glu Ile	
130 135 140	
tct gac aca tgt cct gcg tac gat gaa gaa gcc cgt tct ctg gcg gtg	480
Ser Asp Thr Cys Pro Ala Tyr Asp Glu Glu Ala Arg Ser Leu Ala Val	
145 150 155 160	
gtc ata aaa aac cgt aac ggc ctg cat gta cgt ccg gcc tcc cgg ctg	528
Val Ile Lys Asn Arg Asn Gly Leu His Val Arg Pro Ala Ser Arg Leu	
165 170 175	
ggt tat acc tta tcg aca ttt aat gcc gat atg ttg ctg gaa aaa aac	576
Val Tyr Thr Leu Ser Thr Phe Asn Ala Asp Met Leu Leu Glu Lys Asn	

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180	185	190	
ggc aaa tgc gtc aca cca gag agt att aac cag att gcg tta cta caa Gly Lys Cys Val Thr Pro Glu Ser Ile Asn Gln Ile Ala Leu Leu Gln 195 200 205			624
gtt cgc tat aac gat acg ctg cgc ctg att gcg aaa ggg cca gaa gct Val Arg Tyr Asn Asp Thr Leu Arg Leu Ile Ala Lys Gly Pro Glu Ala 210 215 220			672
gaa gag gca ctg atc gct ttc cgt cag ctg gct gaa gat aac ttt ggt Glu Glu Ala Leu Ile Ala Phe Arg Gln Leu Ala Glu Asp Asn Phe Gly 225 230 235 240			720
gaa acg gag gaa gtc gct cca cct act ctg cgt ccc gtt ccg cct gtt Glu Thr Glu Glu Val Ala Pro Pro Thr Leu Arg Pro Val Pro Pro Val 245 250 255			768
tcg ggt aaa gcc ttt tat tat caa cca gtt tta tgt acg gta cag gca Ser Gly Lys Ala Phe Tyr Tyr Gln Pro Val Leu Cys Thr Val Gln Ala 260 265 270			816
aaa tca acc ctg acc gtg gaa gaa gaa caa gat cga tta cgc cag gct Lys Ser Thr Leu Thr Val Glu Glu Glu Gln Asp Arg Leu Arg Gln Ala 275 280 285			864
att gac ttc acg tta tta gat ctg atg acg tta aca gcg aaa gca gaa Ile Asp Phe Thr Leu Leu Asp Leu Met Thr Leu Thr Ala Lys Ala Glu 290 295 300			912
gcc agc ggg ctt gac gat att gcc gca atc ttt tct ggt cac cat aca Ala Ser Gly Leu Asp Asp Ile Ala Ala Ile Phe Ser Gly His His Thr 305 310 315 320			960
ctg tta gat gat ccg gaa ctg ctg gcg gcg gca agc gaa ctc ctt cag Leu Leu Asp Asp Pro Glu Leu Leu Ala Ala Ala Ser Glu Leu Leu Gln 325 330 335			1008
cat gaa cat tgc acg gca gaa tat gcc tgg cag caa gtt ctt aaa gaa His Glu His Cys Thr Ala Glu Tyr Ala Trp Gln Gln Val Leu Lys Glu 340 345 350			1056
ctt agc cag caa tac cag caa ctg gat gat gaa tat cta caa gct cgc Leu Ser Gln Gln Tyr Gln Gln Leu Asp Asp Glu Tyr Leu Gln Ala Arg 355 360 365			1104
tat att gat gtg gac gat ctt ctg cat cgc acc ctg gtc cac ctg acc Tyr Ile Asp Val Asp Asp Leu Leu His Arg Thr Leu Val His Leu Thr 370 375 380			1152
caa acg aaa gaa gaa ctc ccg cag ttt aac tcg cca act att cta ctg Gln Thr Lys Glu Glu Leu Pro Gln Phe Asn Ser Pro Thr Ile Leu Leu 385 390 395 400			1200
gcg gag aac att tat cct tcc aca gta ctg caa ctg gat ccg gcg gtt Ala Glu Asn Ile Tyr Pro Ser Thr Val Leu Gln Leu Asp Pro Ala Val 405 410 415			1248
gta aaa ggt atc tgc ctt agc gcc gga agt ccg gta tcc cac agc gcc Val Lys Gly Ile Cys Leu Ser Ala Gly Ser Pro Val Ser His Ser Ala 420 425 430			1296
cta atc gcc cgt gaa ctg ggg att ggc tgg att tgc cag cag ggt gag Leu Ile Ala Arg Glu Leu Gly Ile Gly Trp Ile Cys Gln Gln Gly Glu 435 440 445			1344
aaa ctg tat gcg ata caa cca gaa gaa acg cta acg ctg gac gtt aaa Lys Leu Tyr Ala Ile Gln Pro Glu Glu Thr Leu Thr Leu Asp Val Lys 450 455 460			1392
acg caa cgt ttc aac cgt cag ggt taa Thr Gln Arg Phe Asn Arg Gln Gly 465 470			1419

&lt;210&gt; SEQ ID NO 39

&lt;211&gt; LENGTH: 472

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Escherichia coli



-continued

&lt;400&gt; SEQUENCE: 39

Met Val Asn Leu Val Ile Val Ser His Ser Ser Arg Leu Gly Glu Gly  
 1 5 10 15  
 Val Gly Glu Leu Ala Arg Gln Met Leu Met Ser Asp Ser Cys Lys Ile  
 20 25 30  
 Ala Ile Ala Ala Gly Ile Asp Asp Pro Gln Asn Pro Ile Gly Thr Asp  
 35 40 45  
 Ala Val Lys Val Met Glu Ala Ile Glu Ser Val Ala Asp Ala Asp His  
 50 55 60  
 Val Leu Val Met Met Asp Met Gly Ser Ala Leu Leu Ser Ala Glu Thr  
 65 70 75 80  
 Ala Leu Glu Leu Leu Ala Pro Glu Ile Ala Ala Lys Val Arg Leu Cys  
 85 90 95  
 Ala Ala Pro Leu Val Glu Gly Thr Leu Ala Ala Thr Val Ser Ala Ala  
 100 105 110  
 Ser Gly Ala Asp Ile Asp Lys Val Ile Phe Asp Ala Met His Ala Leu  
 115 120 125  
 Glu Ala Lys Arg Glu Gln Leu Gly Leu Pro Ser Ser Asp Thr Glu Ile  
 130 135 140  
 Ser Asp Thr Cys Pro Ala Tyr Asp Glu Glu Ala Arg Ser Leu Ala Val  
 145 150 155 160  
 Val Ile Lys Asn Arg Asn Gly Leu His Val Arg Pro Ala Ser Arg Leu  
 165 170 175  
 Val Tyr Thr Leu Ser Thr Phe Asn Ala Asp Met Leu Leu Glu Lys Asn  
 180 185 190  
 Gly Lys Cys Val Thr Pro Glu Ser Ile Asn Gln Ile Ala Leu Leu Gln  
 195 200 205  
 Val Arg Tyr Asn Asp Thr Leu Arg Leu Ile Ala Lys Gly Pro Glu Ala  
 210 215 220  
 Glu Glu Ala Leu Ile Ala Phe Arg Gln Leu Ala Glu Asp Asn Phe Gly  
 225 230 235 240  
 Glu Thr Glu Glu Val Ala Pro Pro Thr Leu Arg Pro Val Pro Pro Val  
 245 250 255  
 Ser Gly Lys Ala Phe Tyr Tyr Gln Pro Val Leu Cys Thr Val Gln Ala  
 260 265 270  
 Lys Ser Thr Leu Thr Val Glu Glu Glu Gln Asp Arg Leu Arg Gln Ala  
 275 280 285  
 Ile Asp Phe Thr Leu Leu Asp Leu Met Thr Leu Thr Ala Lys Ala Glu  
 290 295 300  
 Ala Ser Gly Leu Asp Asp Ile Ala Ala Ile Phe Ser Gly His His Thr  
 305 310 315 320  
 Leu Leu Asp Asp Pro Glu Leu Leu Ala Ala Ala Ser Glu Leu Leu Gln  
 325 330 335  
 His Glu His Cys Thr Ala Glu Tyr Ala Trp Gln Gln Val Leu Lys Glu  
 340 345 350  
 Leu Ser Gln Gln Tyr Gln Gln Leu Asp Asp Glu Tyr Leu Gln Ala Arg  
 355 360 365  
 Tyr Ile Asp Val Asp Asp Leu Leu His Arg Thr Leu Val His Leu Thr  
 370 375 380  
 Gln Thr Lys Glu Glu Leu Pro Gln Phe Asn Ser Pro Thr Ile Leu Leu  
 385 390 395 400  
 Ala Glu Asn Ile Tyr Pro Ser Thr Val Leu Gln Leu Asp Pro Ala Val  
 405 410 415

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Val Lys Gly Ile Cys Leu Ser Ala Gly Ser Pro Val Ser His Ser Ala  
 420 425 430

Leu Ile Ala Arg Glu Leu Gly Ile Gly Trp Ile Cys Gln Gln Gly Glu  
 435 440 445

Lys Leu Tyr Ala Ile Gln Pro Glu Glu Thr Leu Thr Leu Asp Val Lys  
 450 455 460

Thr Gln Arg Phe Asn Arg Gln Gly  
 465 470

<210> SEQ ID NO 40  
 <211> LENGTH: 1776  
 <212> TYPE: DNA  
 <213> ORGANISM: Schizosaccharomyces pombe  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1776)

<400> SEQUENCE: 40

atg tct gta aaa caa ttt gta tct gaa gga cat ata gta cgc cca tac 48  
 Met Ser Val Lys Gln Phe Val Ser Glu Gly His Ile Val Arg Pro Tyr  
 1 5 10 15

ttg ctt gga ctt gct aga agt aac cct ggc cta act gtt att gaa cat 96  
 Leu Leu Gly Leu Ala Arg Ser Asn Pro Gly Leu Thr Val Ile Glu His  
 20 25 30

gat cgt gta att tac agg aca gcc tct gcc ccg ggt tct ggt gat ccg 144  
 Asp Arg Val Ile Tyr Arg Thr Ala Ser Ala Pro Gly Ser Gly Asp Pro  
 35 40 45

cct aaa gta act tta gtg tct ggt ggt ggt agt ggg cac gag cct aca 192  
 Pro Lys Val Thr Leu Val Ser Gly Gly Gly Ser Gly His Glu Pro Thr  
 50 55 60

cat gct ggt ttt gtt ggt gat gga gcc ttg gac gcc gta gct tgt gga 240  
 His Ala Gly Phe Val Gly Asp Gly Ala Leu Asp Ala Val Ala Cys Gly  
 65 70 75 80

gac att ttt gct tct ccc tct act aaa caa att tac tct gct ctc aaa 288  
 Asp Ile Phe Ala Ser Pro Ser Thr Lys Gln Ile Tyr Ser Ala Leu Lys  
 85 90 95

gct gtt gca tct cct aag gga act tta att att gtc aaa aat tac aca 336  
 Ala Val Ala Ser Pro Lys Gly Thr Leu Ile Ile Val Lys Asn Tyr Thr  
 100 105 110

ggt gat att att cat ttt ggc ttg gca gct gag aga gcc aag gca gct 384  
 Gly Asp Ile Ile His Phe Gly Leu Ala Ala Glu Arg Ala Lys Ala Ala  
 115 120 125

gga atg aac gtt gag ctt gtt gcc gta gga gat gat gtt tct gta ggc 432  
 Gly Met Asn Val Glu Leu Val Ala Val Gly Asp Asp Val Ser Val Gly  
 130 135 140

aaa aag aga ggt gca ctc gta gga cga aga ggt tta gga gcc act gtg 480  
 Lys Lys Arg Gly Ala Leu Val Gly Arg Arg Gly Leu Gly Ala Thr Val  
 145 150 155 160

cta gta cac aaa att gcg gga tct gca gca gca tta gga ctg gat ctg 528  
 Leu Val His Lys Ile Ala Gly Ser Ala Ala Ala Leu Gly Leu Asp Leu  
 165 170 175

cat caa gtt gct caa gtg gcc caa tca gtg att gac aat gct gct acc 576  
 His Gln Val Ala Gln Val Ala Gln Ser Val Ile Asp Asn Ala Ala Thr  
 180 185 190

ata gca gct tca ttg gat cac tgc gcc gtt ccc ggt cgc aaa ttt gaa 624  
 Ile Ala Ala Ser Leu Asp His Cys Ala Val Pro Gly Arg Lys Phe Glu  
 195 200 205

aca aac ttg ggt cca gac gag tat gag att gga atg ggt att cat aac 672  
 Thr Asn Leu Gly Pro Asp Glu Tyr Glu Ile Gly Met Gly Ile His Asn  
 210 215 220

gag cct gga acc ttc aaa tca tca cca ctt cca tct att ccc gag cta 720



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Glu 225	Pro	Gly	Thr	Phe	Lys 230	Ser	Ser	Pro	Leu	Pro 235	Ser	Ile	Pro	Glu	Leu 240	
ggt	aca	gag	atg	ctt	tcg	att	ttg	ttt	ggt	gag	aaa	aac	ccg	gac	aat	768
Val	Thr	Glu	Met	Leu	Ser	Ile	Leu	Phe	Gly	Glu	Lys	Asn	Pro	Asp	Asn	
				245					250					255		
agt	ttc	gta	gag	ttt	tct	tca	aaa	gac	gat	ggt	att	ctt	cta	gta	aac	816
Ser	Phe	Val	Glu	Phe	Ser	Ser	Lys	Asp	Asp	Val	Ile	Leu	Leu	Val	Asn	
			260					265					270			
aat	atg	ggt	ggt	atg	tcc	aac	tta	gag	ttg	gga	tat	gct	act	gaa	gta	864
Asn	Met	Gly	Gly	Met	Ser	Asn	Leu	Glu	Leu	Gly	Tyr	Ala	Thr	Glu	Val	
		275					280					285				
ggt	tcg	gaa	caa	tta	gcc	aaa	cga	ggt	atc	att	cct	aaa	aga	acc	atg	912
Val	Ser	Glu	Gln	Leu	Ala	Lys	Arg	Gly	Ile	Ile	Pro	Lys	Arg	Thr	Met	
		290				295					300					
tct	ggt	act	ttt	gta	acc	gca	ttg	aac	gga	ccg	ggt	ttt	gga	att	aca	960
Ser	Gly	Thr	Phe	Val	Thr	Ala	Leu	Asn	Gly	Pro	Gly	Phe	Gly	Ile	Thr	
305					310					315					320	
ttg	gtc	aat	gct	tct	aag	gct	act	cca	gat	att	ttc	aaa	tat	ttt	gac	1008
Leu	Val	Asn	Ala	Ser	Lys	Ala	Thr	Pro	Asp	Ile	Phe	Lys	Tyr	Phe	Asp	
				325					330					335		
ttg	cca	aca	act	gct	agt	gga	tgg	aac	ggt	tct	tat	cat	aac	gca	aag	1056
Leu	Pro	Thr	Thr	Ala	Ser	Gly	Trp	Asn	Val	Ser	Tyr	His	Asn	Ala	Lys	
			340					345					350			
gac	tgg	gag	ggt	ttg	gct	gac	ggc	aag	gtg	cca	aca	gct	ccc	gct	ttg	1104
Asp	Trp	Glu	Val	Leu	Ala	Asp	Gly	Lys	Val	Pro	Thr	Ala	Pro	Ala	Leu	
		355					360					365				
gag	cat	acc	cgt	aat	gag	aag	cac	agc	ggt	gta	aag	gct	gac	cca	aag	1152
Glu	His	Thr	Arg	Asn	Glu	Lys	His	Ser	Gly	Val	Lys	Ala	Asp	Pro	Lys	
	370					375					380					
atg	ttt	act	aaa	att	tta	aaa	gct	gcc	ggt	gac	gct	atc	aat	gaa	ttt	1200
Met	Phe	Thr	Lys	Ile	Leu	Lys	Ala	Ala	Val	Asp	Ala	Ile	Asn	Glu	Phe	
385					390					395					400	
gag	cca	aag	aca	act	tgg	tac	gat	acg	att	gca	gga	gat	ggt	gat	tgt	1248
Glu	Pro	Lys	Thr	Thr	Trp	Tyr	Asp	Thr	Ile	Ala	Gly	Asp	Gly	Asp	Cys	
				405					410					415		
gga	aca	acc	ctt	gtg	aat	ggt	gga	gag	gcc	atc	ata	aag	gct	att	aat	1296
Gly	Thr	Thr	Leu	Val	Asn	Gly	Gly	Glu	Ala	Ile	Ile	Lys	Ala	Ile	Asn	
			420					425					430			
gat	aaa	tca	att	cga	ttg	gat	gat	ggt	gta	aat	ggt	att	gac	gat	ttg	1344
Asp	Lys	Ser	Ile	Arg	Leu	Asp	Asp	Gly	Val	Asn	Gly	Ile	Asp	Asp	Leu	
		435					440					445				
gcc	tat	att	ggt	gag	gat	tcg	atg	gga	ggt	aca	tcg	ggt	ggt	ctt	tac	1392
Ala	Tyr	Ile	Val	Glu	Asp	Ser	Met	Gly	Gly	Thr	Ser	Gly	Gly	Leu	Tyr	
	450					455					460					
tcg	att	tat	ttg	tct	gcg	cta	gcc	aaa	gga	ggt	cgt	gag	tca	ggc	gat	1440
Ser	Ile	Tyr	Leu	Ser	Ala	Leu	Ala	Lys	Gly	Val	Arg	Glu	Ser	Gly	Asp	
465					470					475					480	
tcc	gaa	tta	tcc	gtg	cat	acg	ttt	gcg	ttt	gca	agc	aag	tat	gca	ctt	1488
Ser	Glu	Leu	Ser	Val	His	Thr	Phe	Ala	Phe	Ala	Ser	Lys	Tyr	Ala	Leu	
				485					490					495		
gac	gct	ctt	ttc	aaa	tac	act	agg	gcc	cgt	aaa	gga	ttc	cgt	act	ctg	1536
Asp	Ala	Leu	Phe	Lys	Tyr	Thr	Arg	Ala	Arg	Lys	Gly	Phe	Arg	Thr	Leu	
			500					505					510			
atc	gat	gct	att	caa	cca	ttt	ggt	gaa	act	tta	aat	gaa	ggt	aag	gga	1584
Ile	Asp	Ala	Ile	Gln	Pro	Phe	Val	Glu	Thr	Leu	Asn	Glu	Gly	Lys	Gly	
		515					520					525				
ctt	gat	gct	gct	gcg	aaa	gct	gcc	acg	gaa	ggt	tct	gaa	caa	act	aga	1632
Leu	Asp	Ala	Ala	Ala	Lys	Ala	Ala	Thr	Glu	Gly	Ser	Glu	Gln	Thr	Arg	
	530					535					540					
aaa	atg	gat	gct	gtc	ggt	gga	aga	gcg	tct	tat	ggt	gct	aaa	gag	gaa	1680

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Lys	Met	Asp	Ala	Val	Val	Gly	Arg	Ala	Ser	Tyr	Val	Ala	Lys	Glu	Glu		
545					550					555					560		
ctt	cat	aag	ctt	gat	agt	gag	gga	ggc	tta	ccg	gat	cct	ggt	gcc	ttt		1728
Leu	His	Lys	Leu	Asp	Ser	Glu	Gly	Gly	Leu	Pro	Asp	Pro	Gly	Ala	Phe		
			565						570					575			
gcg	tta	gcg	gcg	atc	ttg	aaa	gca	att	gtt	gag	gct	agt	gaa	cat	taa		1776
Ala	Leu	Ala	Ala	Ile	Leu	Lys	Ala	Ile	Val	Glu	Ala	Ser	Glu	His			
			580					585						590			

<210> SEQ ID NO 41  
 <211> LENGTH: 591  
 <212> TYPE: PRT  
 <213> ORGANISM: Schizosaccharomyces pombe

<400> SEQUENCE: 41

Met	Ser	Val	Lys	Gln	Phe	Val	Ser	Glu	Gly	His	Ile	Val	Arg	Pro	Tyr		
1				5					10					15			
Leu	Leu	Gly	Leu	Ala	Arg	Ser	Asn	Pro	Gly	Leu	Thr	Val	Ile	Glu	His		
			20					25					30				
Asp	Arg	Val	Ile	Tyr	Arg	Thr	Ala	Ser	Ala	Pro	Gly	Ser	Gly	Asp	Pro		
		35					40					45					
Pro	Lys	Val	Thr	Leu	Val	Ser	Gly	Gly	Gly	Ser	Gly	His	Glu	Pro	Thr		
		50				55					60						
His	Ala	Gly	Phe	Val	Gly	Asp	Gly	Ala	Leu	Asp	Ala	Val	Ala	Cys	Gly		
65					70					75				80			
Asp	Ile	Phe	Ala	Ser	Pro	Ser	Thr	Lys	Gln	Ile	Tyr	Ser	Ala	Leu	Lys		
				85					90					95			
Ala	Val	Ala	Ser	Pro	Lys	Gly	Thr	Leu	Ile	Ile	Val	Lys	Asn	Tyr	Thr		
			100					105					110				
Gly	Asp	Ile	Ile	His	Phe	Gly	Leu	Ala	Ala	Glu	Arg	Ala	Lys	Ala	Ala		
		115					120					125					
Gly	Met	Asn	Val	Glu	Leu	Val	Ala	Val	Gly	Asp	Asp	Val	Ser	Val	Gly		
	130					135					140						
Lys	Lys	Arg	Gly	Ala	Leu	Val	Gly	Arg	Arg	Gly	Leu	Gly	Ala	Thr	Val		
145					150					155				160			
Leu	Val	His	Lys	Ile	Ala	Gly	Ser	Ala	Ala	Ala	Leu	Gly	Leu	Asp	Leu		
			165						170					175			
His	Gln	Val	Ala	Gln	Val	Ala	Gln	Ser	Val	Ile	Asp	Asn	Ala	Ala	Thr		
			180					185					190				
Ile	Ala	Ala	Ser	Leu	Asp	His	Cys	Ala	Val	Pro	Gly	Arg	Lys	Phe	Glu		
		195					200					205					
Thr	Asn	Leu	Gly	Pro	Asp	Glu	Tyr	Glu	Ile	Gly	Met	Gly	Ile	His	Asn		
	210					215					220						
Glu	Pro	Gly	Thr	Phe	Lys	Ser	Ser	Pro	Leu	Pro	Ser	Ile	Pro	Glu	Leu		
225					230					235				240			
Val	Thr	Glu	Met	Leu	Ser	Ile	Leu	Phe	Gly	Glu	Lys	Asn	Pro	Asp	Asn		
				245					250					255			
Ser	Phe	Val	Glu	Phe	Ser	Ser	Lys	Asp	Asp	Val	Ile	Leu	Leu	Val	Asn		
		260						265					270				
Asn	Met	Gly	Gly	Met	Ser	Asn	Leu	Glu	Leu	Gly	Tyr	Ala	Thr	Glu	Val		
		275					280					285					
Val	Ser	Glu	Gln	Leu	Ala	Lys	Arg	Gly	Ile	Ile	Pro	Lys	Arg	Thr	Met		
		290				295					300						
Ser	Gly	Thr	Phe	Val	Thr	Ala	Leu	Asn	Gly	Pro	Gly	Phe	Gly	Ile	Thr		
305					310					315				320			
Leu	Val	Asn	Ala	Ser	Lys	Ala	Thr	Pro	Asp	Ile	Phe	Lys	Tyr	Phe	Asp		



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325					330					335					
Leu	Pro	Thr	Thr	Ala	Ser	Gly	Trp	Asn	Val	Ser	Tyr	His	Asn	Ala	Lys
			340					345					350		
Asp	Trp	Glu	Val	Leu	Ala	Asp	Gly	Lys	Val	Pro	Thr	Ala	Pro	Ala	Leu
		355					360					365			
Glu	His	Thr	Arg	Asn	Glu	Lys	His	Ser	Gly	Val	Lys	Ala	Asp	Pro	Lys
	370					375					380				
Met	Phe	Thr	Lys	Ile	Leu	Lys	Ala	Ala	Val	Asp	Ala	Ile	Asn	Glu	Phe
385					390					395					400
Glu	Pro	Lys	Thr	Thr	Trp	Tyr	Asp	Thr	Ile	Ala	Gly	Asp	Gly	Asp	Cys
				405					410					415	
Gly	Thr	Thr	Leu	Val	Asn	Gly	Gly	Glu	Ala	Ile	Ile	Lys	Ala	Ile	Asn
			420					425					430		
Asp	Lys	Ser	Ile	Arg	Leu	Asp	Asp	Gly	Val	Asn	Gly	Ile	Asp	Asp	Leu
		435					440					445			
Ala	Tyr	Ile	Val	Glu	Asp	Ser	Met	Gly	Gly	Thr	Ser	Gly	Gly	Leu	Tyr
	450					455					460				
Ser	Ile	Tyr	Leu	Ser	Ala	Leu	Ala	Lys	Gly	Val	Arg	Glu	Ser	Gly	Asp
465					470					475					480
Ser	Glu	Leu	Ser	Val	His	Thr	Phe	Ala	Phe	Ala	Ser	Lys	Tyr	Ala	Leu
				485					490					495	
Asp	Ala	Leu	Phe	Lys	Tyr	Thr	Arg	Ala	Arg	Lys	Gly	Phe	Arg	Thr	Leu
		500						505					510		
Ile	Asp	Ala	Ile	Gln	Pro	Phe	Val	Glu	Thr	Leu	Asn	Glu	Gly	Lys	Gly
		515					520					525			
Leu	Asp	Ala	Ala	Ala	Lys	Ala	Ala	Thr	Glu	Gly	Ser	Glu	Gln	Thr	Arg
		530				535					540				
Lys	Met	Asp	Ala	Val	Val	Gly	Arg	Ala	Ser	Tyr	Val	Ala	Lys	Glu	Glu
545					550					555					560
Leu	His	Lys	Leu	Asp	Ser	Glu	Gly	Gly	Leu	Pro	Asp	Pro	Gly	Ala	Phe
				565					570					575	
Ala	Leu	Ala	Ala	Ile	Leu	Lys	Ala	Ile	Val	Glu	Ala	Ser	Glu	His	
			580					585					590		

<210> SEQ ID NO 42  
 <211> LENGTH: 1830  
 <212> TYPE: DNA  
 <213> ORGANISM: Pichia angusta  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1830)

<400> SEQUENCE: 42

atg	tcg	agc	aaa	cac	tgg	aat	tac	aag	caa	gac	ctg	gtc	cat	gcg	cac	48
Met	Ser	Ser	Lys	His	Trp	Asn	Tyr	Lys	Gln	Asp	Leu	Val	His	Ala	His	
1				5					10					15		
ctc	aaa	ggc	ctg	tgt	cat	gcc	aat	cca	gac	ctc	caa	ttc	atc	gaa	tcc	96
Leu	Lys	Gly	Leu	Cys	His	Ala	Asn	Pro	Asp	Leu	Gln	Phe	Ile	Glu	Ser	
			20					25					30			
gag	cgt	gtg	gtg	atc	aac	aag	cac	tcc	aag	ccc	gac	aag	gtg	atg	atc	144
Glu	Arg	Val	Val	Ile	Asn	Lys	His	Ser	Lys	Pro	Asp	Lys	Val	Met	Ile	
		35				40						45				
cta	tct	ggt	gga	ggg	tct	ggc	cac	gag	cca	ttg	cac	gct	ggc	ttt	gtt	192
Leu	Ser	Gly	Gly	Gly	Ser	Gly	His	Glu	Pro	Leu	His	Ala	Gly	Phe	Val	
		50				55					60					
ggt	gaa	ggc	tgt	ttg	gac	ggt	gga	gtg	gct	ggt	ttt	ggt	ttc	gcc	tcg	240
Gly	Glu	Gly	Cys	Leu	Asp	Val	Gly	Val	Ala	Gly	Phe	Val	Phe	Ala	Ser	
65					70					75				80		

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ccc tct aca aag cag att gtt tca ggt ttg aag gca aag ccc tca gac	288
Pro Ser Thr Lys Gln Ile Val Ser Gly Leu Lys Ala Lys Pro Ser Asp	
85 90 95	
aaa ggt acg cta att gtg gtg aaa aat tac acc ggc gac att ctt cac	336
Lys Gly Thr Leu Ile Val Val Lys Asn Tyr Thr Gly Asp Ile Leu His	
100 105 110	
ttt ggg ctt gct gca gag cgg gcc aag gcc gaa ggc gtc ccc gtg gag	384
Phe Gly Leu Ala Ala Glu Arg Ala Lys Ala Glu Gly Val Pro Val Glu	
115 120 125	
ctg cta att gtc cag gac gac gtt tct gtg ggc aga acc aag aac gga	432
Leu Leu Ile Val Gln Asp Asp Val Ser Val Gly Arg Thr Lys Asn Gly	
130 135 140	
atg gtg ggc aga cgc ggt ctg gcc ggt acg agt ctg gtg cac aag att	480
Met Val Gly Arg Arg Gly Leu Ala Gly Thr Ser Leu Val His Lys Ile	
145 150 155 160	
gtc ggt gcc aag gcc gcc aag gac tgc aac aaa gcc tcg ttg agc gag	528
Val Gly Ala Lys Ala Ala Lys Asp Ser Asn Lys Ala Ser Leu Ser Glu	
165 170 175	
gtg tac cag ctg ggc gag gcc gtg gtg gcc aat ctg gtg acc atc ggc	576
Val Tyr Gln Leu Gly Glu Ala Val Val Ala Asn Leu Val Thr Ile Gly	
180 185 190	
gcg tcg ctc gac cac tgc aca att ccg ggt aac aga cac cac gag tcc	624
Ala Ser Leu Asp His Cys Thr Ile Pro Gly Asn Arg His His Glu Ser	
195 200 205	
gag tcc gac gac gag gac gag cag aaa cat ctg ctc aag gag gac gag	672
Glu Ser Asp Asp Glu Asp Glu Gln Lys His Leu Leu Lys Glu Asp Glu	
210 215 220	
atc gag gtg ggt atg ggg atc cac aac gag tcg ggc atc aag cgc gtt	720
Ile Glu Val Gly Met Gly Ile His Asn Glu Ser Gly Ile Lys Arg Val	
225 230 235 240	
tcg cca atc ccg acc atc gac acg ctt gtg gca gac ctg ctc aag tac	768
Ser Pro Ile Pro Thr Ile Asp Thr Leu Val Ala Asp Leu Leu Lys Tyr	
245 250 255	
ttg ctc gac aag agc gac gag gag aga cac tat gtg gac ttc gac tcg	816
Leu Leu Asp Lys Ser Asp Glu Glu Arg His Tyr Val Asp Phe Asp Ser	
260 265 270	
tcg gac gag gtt gtg ctg atg atc aac aat ttg ggc ggc acg tcg aac	864
Ser Asp Glu Val Val Leu Met Ile Asn Asn Leu Gly Gly Thr Ser Asn	
275 280 285	
ctc gag ctg tac gct atc cag aac act gtt gtt gag cag ctg gct acc	912
Leu Glu Leu Tyr Ala Ile Gln Asn Thr Val Val Glu Gln Leu Ala Thr	
290 295 300	
gac tac aag atc aag ccc gca aga gtg tac acg ggc gcg tac acc acg	960
Asp Tyr Lys Ile Lys Pro Ala Arg Val Tyr Thr Gly Ala Tyr Thr Thr	
305 310 315 320	
tcg cta gac ggt cct ggt ttt tcc atc acg ttg ctg aac gtg act cgg	1008
Ser Leu Asp Gly Pro Gly Phe Ser Ile Thr Leu Leu Asn Val Thr Arg	
325 330 335	
gcg ggg ggc aag gag gtt ttc gat tgt ctg gac tac cca acc aag gtt	1056
Ala Gly Gly Lys Glu Val Phe Asp Cys Leu Asp Tyr Pro Thr Lys Val	
340 345 350	
cct ggg tgg aac tcg tcg tac aca acg gca gaa tgg gcg gcg aaa tcc	1104
Pro Gly Trp Asn Ser Ser Tyr Thr Thr Ala Glu Trp Ala Ala Lys Ser	
355 360 365	
gag tcg ttc gtc atc gac gct ccg cca gtg agc gac gcg tcg gcg acc	1152
Glu Ser Phe Val Ile Asp Ala Pro Pro Val Ser Asp Ala Ser Ala Thr	
370 375 380	
tcg aaa gtg cgg ttc tca agc agc aca gtc aag gct gtg ttg gag agc	1200
Ser Lys Val Arg Phe Ser Ser Ser Thr Val Lys Ala Val Leu Glu Ser	
385 390 395 400	



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gga tgc aag aag ttg ctg acc aag gag cca aag atc acg ctg tac gac 1248  
 Gly Cys Lys Lys Leu Leu Thr Lys Glu Pro Lys Ile Thr Leu Tyr Asp  
 405 410 415

acg gtt gcg ggc gac ggc gac tgc ggc gag acg ctg gcc aac ggc gcg 1296  
 Thr Val Ala Gly Asp Gly Asp Cys Gly Glu Thr Leu Ala Asn Gly Ala  
 420 425 430

cac gcg atc ctg gac ctg ctg gct gcc gac aag ctg gag atc acc gac 1344  
 His Ala Ile Leu Asp Leu Leu Ala Ala Asp Lys Leu Glu Ile Thr Asp  
 435 440 445

ggt gtc cgg agt ctg acg cag atc act gac gtc gtc gaa acg gct atg 1392  
 Gly Val Arg Ser Leu Thr Gln Ile Thr Asp Val Val Glu Thr Ala Met  
 450 455 460

gga ggc acc tct ggt ggg ctt tac tcg atc ttt atc tct gca ctc gcc 1440  
 Gly Gly Thr Ser Gly Gly Leu Tyr Ser Ile Phe Ile Ser Ala Leu Ala  
 465 470 475 480

aag tcg ttg aag gac aga gag ctc cag cag ggc gga tac gag gtg acg 1488  
 Lys Ser Leu Lys Asp Arg Glu Leu Gln Gln Gly Gly Tyr Glu Val Thr  
 485 490 495

ccg cag atc ctg gct gca tcg ctc aag gac gcc ctg gag tcg ctg tac 1536  
 Pro Gln Ile Leu Ala Ala Ser Leu Lys Asp Ala Leu Glu Ser Leu Tyr  
 500 505 510

aga tac aca cgg gcc cgt gct ggc gac cgg act ctg atc gac gcg ctt 1584  
 Arg Tyr Thr Arg Ala Arg Ala Gly Asp Arg Thr Leu Ile Asp Ala Leu  
 515 520 525

gcg ccg ttt gtg gag cag ttt gcg gcc agc aag ggt gac ctc aac cag 1632  
 Ala Pro Phe Val Glu Gln Phe Ala Ala Ser Lys Gly Asp Leu Asn Gln  
 530 535 540

gct aac aag gcg tgc cac gag gga gca gag tca acg cga aag ctc aag 1680  
 Ala Asn Lys Ala Cys His Glu Gly Ala Glu Ser Thr Arg Lys Leu Lys  
 545 550 555 560

gct aag ttt ggc cgc gcg tcc tac gtc agc gag gag gag ttc aag ccg 1728  
 Ala Lys Phe Gly Arg Ala Ser Tyr Val Ser Glu Glu Glu Phe Lys Pro  
 565 570 575

ttt gag gcc gag ggc ggg ctg ccg gat ccc ggc gcc atc ggg ctt gct 1776  
 Phe Glu Ala Glu Gly Gly Leu Pro Asp Pro Gly Ala Ile Gly Leu Ala  
 580 585 590

gcg ctg gtc gac ggt ttt gcc gag gcg tac agc aaa ata ggc tcc aac 1824  
 Ala Leu Val Asp Gly Phe Ala Glu Ala Tyr Ser Lys Ile Gly Ser Asn  
 595 600 605

ttg tag 1830  
 Leu

<210> SEQ ID NO 43  
 <211> LENGTH: 609  
 <212> TYPE: PRT  
 <213> ORGANISM: Pichia angusta

<400> SEQUENCE: 43

Met Ser Ser Lys His Trp Asn Tyr Lys Gln Asp Leu Val His Ala His  
 1 5 10 15

Leu Lys Gly Leu Cys His Ala Asn Pro Asp Leu Gln Phe Ile Glu Ser  
 20 25 30

Glu Arg Val Val Ile Asn Lys His Ser Lys Pro Asp Lys Val Met Ile  
 35 40 45

Leu Ser Gly Gly Gly Ser Gly His Glu Pro Leu His Ala Gly Phe Val  
 50 55 60

Gly Glu Gly Cys Leu Asp Val Gly Val Ala Gly Phe Val Phe Ala Ser  
 65 70 75 80

Pro Ser Thr Lys Gln Ile Val Ser Gly Leu Lys Ala Lys Pro Ser Asp

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85					90					95					
Lys	Gly	Thr	Leu	Ile	Val	Val	Lys	Asn	Tyr	Thr	Gly	Asp	Ile	Leu	His
			100					105					110		
Phe	Gly	Leu	Ala	Ala	Glu	Arg	Ala	Lys	Ala	Glu	Gly	Val	Pro	Val	Glu
		115					120					125			
Leu	Leu	Ile	Val	Gln	Asp	Asp	Val	Ser	Val	Gly	Arg	Thr	Lys	Asn	Gly
	130					135					140				
Met	Val	Gly	Arg	Arg	Gly	Leu	Ala	Gly	Thr	Ser	Leu	Val	His	Lys	Ile
145					150					155					160
Val	Gly	Ala	Lys	Ala	Ala	Lys	Asp	Ser	Asn	Lys	Ala	Ser	Leu	Ser	Glu
				165					170					175	
Val	Tyr	Gln	Leu	Gly	Glu	Ala	Val	Val	Ala	Asn	Leu	Val	Thr	Ile	Gly
			180					185						190	
Ala	Ser	Leu	Asp	His	Cys	Thr	Ile	Pro	Gly	Asn	Arg	His	His	Glu	Ser
		195					200					205			
Glu	Ser	Asp	Asp	Glu	Asp	Glu	Gln	Lys	His	Leu	Leu	Lys	Glu	Asp	Glu
	210					215					220				
Ile	Glu	Val	Gly	Met	Gly	Ile	His	Asn	Glu	Ser	Gly	Ile	Lys	Arg	Val
225					230					235					240
Ser	Pro	Ile	Pro	Thr	Ile	Asp	Thr	Leu	Val	Ala	Asp	Leu	Leu	Lys	Tyr
				245					250					255	
Leu	Leu	Asp	Lys	Ser	Asp	Glu	Glu	Arg	His	Tyr	Val	Asp	Phe	Asp	Ser
			260					265					270		
Ser	Asp	Glu	Val	Val	Leu	Met	Ile	Asn	Asn	Leu	Gly	Gly	Thr	Ser	Asn
	275						280					285			
Leu	Glu	Leu	Tyr	Ala	Ile	Gln	Asn	Thr	Val	Val	Glu	Gln	Leu	Ala	Thr
	290					295					300				
Asp	Tyr	Lys	Ile	Lys	Pro	Ala	Arg	Val	Tyr	Thr	Gly	Ala	Tyr	Thr	Thr
305					310					315					320
Ser	Leu	Asp	Gly	Pro	Gly	Phe	Ser	Ile	Thr	Leu	Leu	Asn	Val	Thr	Arg
				325					330					335	
Ala	Gly	Gly	Lys	Glu	Val	Phe	Asp	Cys	Leu	Asp	Tyr	Pro	Thr	Lys	Val
			340					345					350		
Pro	Gly	Trp	Asn	Ser	Ser	Tyr	Thr	Thr	Ala	Glu	Trp	Ala	Ala	Lys	Ser
		355					360					365			
Glu	Ser	Phe	Val	Ile	Asp	Ala	Pro	Pro	Val	Ser	Asp	Ala	Ser	Ala	Thr
	370					375					380				
Ser	Lys	Val	Arg	Phe	Ser	Ser	Ser	Thr	Val	Lys	Ala	Val	Leu	Glu	Ser
385					390					395					400
Gly	Cys	Lys	Lys	Leu	Leu	Thr	Lys	Glu	Pro	Lys	Ile	Thr	Leu	Tyr	Asp
				405					410					415	
Thr	Val	Ala	Gly	Asp	Gly	Asp	Cys	Gly	Glu	Thr	Leu	Ala	Asn	Gly	Ala
			420					425					430		
His	Ala	Ile	Leu	Asp	Leu	Leu	Ala	Ala	Asp	Lys	Leu	Glu	Ile	Thr	Asp
		435					440					445			
Gly	Val	Arg	Ser	Leu	Thr	Gln	Ile	Thr	Asp	Val	Val	Glu	Thr	Ala	Met
	450					455					460				
Gly	Gly	Thr	Ser	Gly	Gly	Leu	Tyr	Ser	Ile	Phe	Ile	Ser	Ala	Leu	Ala
465					470					475					480
Lys	Ser	Leu	Lys	Asp	Arg	Glu	Leu	Gln	Gln	Gly	Gly	Tyr	Glu	Val	Thr
				485					490					495	
Pro	Gln	Ile	Leu	Ala	Ala	Ser	Leu	Lys	Asp	Ala	Leu	Glu	Ser	Leu	Tyr
			500					505					510		



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Arg Tyr Thr Arg Ala Arg Ala Gly Asp Arg Thr Leu Ile Asp Ala Leu  
 515 520 525

Ala Pro Phe Val Glu Gln Phe Ala Ala Ser Lys Gly Asp Leu Asn Gln  
 530 535 540

Ala Asn Lys Ala Cys His Glu Gly Ala Glu Ser Thr Arg Lys Leu Lys  
 545 550 555 560

Ala Lys Phe Gly Arg Ala Ser Tyr Val Ser Glu Glu Glu Phe Lys Pro  
 565 570 575

Phe Glu Ala Glu Gly Gly Leu Pro Asp Pro Gly Ala Ile Gly Leu Ala  
 580 585 590

Ala Leu Val Asp Gly Phe Ala Glu Ala Tyr Ser Lys Ile Gly Ser Asn  
 595 600 605

Leu

<210> SEQ ID NO 44  
 <211> LENGTH: 1827  
 <212> TYPE: DNA  
 <213> ORGANISM: Pichia pastoris  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1827)

&lt;400&gt; SEQUENCE: 44

atg tct agt aaa cat tgg gat tac aag aaa gat ctg gta ctc agc cat 48  
 Met Ser Ser Lys His Trp Asp Tyr Lys Lys Asp Leu Val Leu Ser His  
 1 5 10 15

ctg gct gga tta tgt cag tcc aac ccc cat gta agg cta att gag tcc 96  
 Leu Ala Gly Leu Cys Gln Ser Asn Pro His Val Arg Leu Ile Glu Ser  
 20 25 30

gaa aga gtc gtc atc tcc gcc gag aac cag gag gac aag att acc ttg 144  
 Glu Arg Val Val Ile Ser Ala Glu Asn Gln Glu Asp Lys Ile Thr Leu  
 35 40 45

atc tct ggt gga ggt tca gga cac gag cct cta cat gct ggc ttt gtc 192  
 Ile Ser Gly Gly Gly Ser Gly His Glu Pro Leu His Ala Gly Phe Val  
 50 55 60

acc aag gac ggt ctt ttg gat gcc gct gtg gcc ggg ttc atc ttt gcc 240  
 Thr Lys Asp Gly Leu Leu Asp Ala Ala Val Ala Gly Phe Ile Phe Ala  
 65 70 75 80

tcg cca tct act aaa cag ata ttt agc gca atc aaa gcc aaa cct tcg 288  
 Ser Pro Ser Thr Lys Gln Ile Phe Ser Ala Ile Lys Ala Lys Pro Ser  
 85 90 95

aag aag gga act ttg atc atc gtc aag aac tat aca gga gac att ctt 336  
 Lys Lys Gly Thr Leu Ile Ile Val Lys Asn Tyr Thr Gly Asp Ile Leu  
 100 105 110

cac ttc ggt ctt gcc gcc gaa aag gcc aag gcc gaa ggt ctc aac gca 384  
 His Phe Gly Leu Ala Ala Glu Lys Ala Lys Ala Glu Gly Leu Asn Ala  
 115 120 125

gaa ctg ctg att gtt cag gac gat gtc tct gtt ggt aaa gcc aag aat 432  
 Glu Leu Leu Ile Val Gln Asp Asp Val Ser Val Gly Lys Ala Lys Asn  
 130 135 140

ggc ctg gta ggg cgt aga ggt ttg gct gga act tct tta gtg cac aag 480  
 Gly Leu Val Gly Arg Arg Gly Leu Ala Gly Thr Ser Leu Val His Lys  
 145 150 155 160

att ttg ggt gcc aaa gct tat tta caa aag gac aac ctg gaa ttg cat 528  
 Ile Leu Gly Ala Lys Ala Tyr Leu Gln Lys Asp Asn Leu Glu Leu His  
 165 170 175

cag ctg gtc act ttc ggt gag aag gtc gtt gcc aac ctg gtt aca att 576  
 Gln Leu Val Thr Phe Gly Glu Lys Val Val Ala Asn Leu Val Thr Ile  
 180 185 190

ggc gct tcc ttg gac cat gtc acc att cca gcc aga gca aac aaa cag 624

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Gly	Ala	Ser	Leu	Asp	His	Val	Thr	Ile	Pro	Ala	Arg	Ala	Asn	Lys	Gln		
		195					200					205					
gag	gaa	gat	gat	tca	gat	gac	gag	cac	ggc	tac	gaa	gtg	cta	aag	cac	672	
Glu	Glu	Asp	Asp	Ser	Asp	Asp	Glu	His	Gly	Tyr	Glu	Val	Leu	Lys	His		
	210					215				220							
gat	gaa	ttt	gaa	atc	gga	atg	ggg	att	cac	aac	gaa	cca	ggt	atc	aag	720	
Asp	Glu	Phe	Glu	Ile	Gly	Met	Gly	Ile	His	Asn	Glu	Pro	Gly	Ile	Lys		
	225				230					235					240		
aag	tcg	tcg	cca	att	cca	aca	gta	gac	gaa	ttg	gtg	gct	gag	cta	ctg	768	
Lys	Ser	Ser	Pro	Ile	Pro	Thr	Val	Asp	Glu	Leu	Val	Ala	Glu	Leu	Leu		
				245					250					255			
gag	tac	ctt	ctt	tcg	act	acc	gat	aag	gac	cga	aat	tac	gtc	caa	ttt	816	
Glu	Tyr	Leu	Leu	Ser	Thr	Thr	Asp	Lys	Asp	Arg	Asn	Tyr	Val	Gln	Phe		
			260					265					270				
gac	aag	aat	gat	gaa	gtt	gtg	cta	ctg	atc	aat	aac	ttg	gga	gga	acc	864	
Asp	Lys	Asn	Asp	Glu	Val	Val	Leu	Leu	Ile	Asn	Asn	Leu	Gly	Gly	Thr		
		275					280					285					
tca	gtg	ttg	gaa	ttg	tac	gct	att	cag	aac	att	gtt	gtc	gac	caa	ctg	912	
Ser	Val	Leu	Glu	Leu	Tyr	Ala	Ile	Gln	Asn	Ile	Val	Val	Asp	Gln	Leu		
	290					295					300						
gcc	tcc	aaa	tat	tcc	att	aaa	cca	gtc	cgc	att	ttc	act	ggc	act	ttc	960	
Ala	Ser	Lys	Tyr	Ser	Ile	Lys	Pro	Val	Arg	Ile	Phe	Thr	Gly	Thr	Phe		
	305				310					315					320		
acc	aca	tca	ctg	gat	ggg	ccc	ggg	ttt	tct	atc	act	tta	ttg	aat	gct	1008	
Thr	Thr	Ser	Leu	Asp	Gly	Pro	Gly	Phe	Ser	Ile	Thr	Leu	Leu	Asn	Ala		
				325					330					335			
acc	aag	aca	gga	gat	aaa	gat	atc	cta	aag	ttt	tta	gac	cac	aag	act	1056	
Thr	Lys	Thr	Gly	Asp	Lys	Asp	Ile	Leu	Lys	Phe	Leu	Asp	His	Lys	Thr		
			340					345					350				
agt	gcc	cct	ggc	tgg	aac	tcc	aac	ata	tca	gac	tgg	tct	ggc	agg	ggt	1104	
Ser	Ala	Pro	Gly	Trp	Asn	Ser	Asn	Ile	Ser	Asp	Trp	Ser	Gly	Arg	Val		
		355					360						365				
gac	aat	ttt	att	gtg	gct	gcc	cca	gaa	ata	gac	gaa	gga	gac	agt	tca	1152	
Asp	Asn	Phe	Ile	Val	Ala	Ala	Pro	Glu	Ile	Asp	Glu	Gly	Asp	Ser	Ser		
	370					375					380						
tct	aag	gta	tct	ggt	gat	gct	aag	ctg	tat	gct	gac	ctt	ctg	gag	tct	1200	
Ser	Lys	Val	Ser	Val	Asp	Ala	Lys	Leu	Tyr	Ala	Asp	Leu	Leu	Glu	Ser		
					390					395					400		
ggg	gtg	aag	aag	gtc	att	tca	aaa	gag	cca	aag	atc	aca	ttg	tat	gac	1248	
Gly	Val	Lys	Lys	Val	Ile	Ser	Lys	Glu	Pro	Lys	Ile	Thr	Leu	Tyr	Asp		
				405					410					415			
act	ggt	gca	gga	gat	ggg	gat	tgt	ggg	gaa	acg	ttg	gcg	aat	ggg	tcc	1296	
Thr	Val	Ala	Gly	Asp	Gly	Asp	Cys	Gly	Glu	Thr	Leu	Ala	Asn	Gly	Ser		
			420					425					430				
aat	gcc	att	tta	aag	gct	ctg	gct	gaa	gga	aag	ctt	gat	ctc	aaa	gac	1344	
Asn	Ala	Ile	Leu	Lys	Ala	Leu	Ala	Glu	Gly	Lys	Leu	Asp	Leu	Lys	Asp		
			435				440					445					
ggg	ggt	aaa	tca	ctg	gtg	caa	att	aca	gac	atc	gtg	gaa	act	gcc	atg	1392	
Gly	Val	Lys	Ser	Leu	Val	Gln	Ile	Thr	Asp	Ile	Val	Glu	Thr	Ala	Met		
					450		455				460						
ggg	gga	aca	tct	gga	ggg	ctg	tac	tcc	att	ttc	atc	agc	gct	tta	gca	1440	
Gly	Gly	Thr	Ser	Gly	Gly	Leu	Tyr	Ser	Ile	Phe	Ile	Ser	Ala	Leu	Ala		
	465				470					475					480		
aag	tct	ttg	aaa	gag	aag	gaa	ctt	tcc	gag	ggg	gcc	tac	aca	ctg	acc	1488	
Lys	Ser	Leu	Lys	Glu	Lys	Glu	Leu	Ser	Glu	Gly	Ala	Tyr	Thr	Leu	Thr		
				485					490					495			
ctt	gaa	acg	atc	tct	gga	tcc	tta	cag	gca	gca	ctt	cag	tct	cta	ttc	1536	
Leu	Glu	Thr	Ile	Ser	Gly	Ser	Leu	Gln	Ala	Ala	Leu	Gln	Ser	Leu	Phe		
			500					505					510				
aaa	tac	aca	aga	gca	cgt	act	gga	gac	aga	act	ctt	att	gac	gct	ttg	1584	



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Lys	Tyr	Thr	Arg	Ala	Arg	Thr	Gly	Asp	Arg	Thr	Leu	Ile	Asp	Ala	Leu		
		515					520					525					
gag	cca	ttt	gta	aag	gaa	ttc	gcc	aag	tct	aag	gat	ctg	aaa	ctt	gca	1632	
Glu	Pro	Phe	Val	Lys	Glu	Phe	Ala	Lys	Ser	Lys	Asp	Leu	Lys	Leu	Ala		
	530					535					540						
aac	aaa	gct	gcc	cat	gat	ggg	gct	gaa	gcc	aca	aga	aag	ctc	gaa	gcc	1680	
Asn	Lys	Ala	Ala	His	Asp	Gly	Ala	Glu	Ala	Thr	Arg	Lys	Leu	Glu	Ala		
545				550						555				560			
aag	ttt	gga	aga	gca	tct	tat	ggt	gcc	gaa	gaa	gag	ttc	aaa	caa	ttc	1728	
Lys	Phe	Gly	Arg	Ala	Ser	Tyr	Val	Ala	Glu	Glu	Glu	Phe	Lys	Gln	Phe		
			565					570						575			
gaa	agt	gaa	ggg	gga	cta	cct	gat	cct	ggg	gct	att	ggg	ctt	gcc	gct	1776	
Glu	Ser	Glu	Gly	Gly	Leu	Pro	Asp	Pro	Gly	Ala	Ile	Gly	Leu	Ala	Ala		
			580					585					590				
ttg	att	tca	gga	att	act	gat	gca	tac	ttc	aaa	tct	gaa	acc	aag	ttg	1824	
Leu	Ile	Ser	Gly	Ile	Thr	Asp	Ala	Tyr	Phe	Lys	Ser	Glu	Thr	Lys	Leu		
		595					600					605					
tag																1827	

&lt;210&gt; SEQ ID NO 45

&lt;211&gt; LENGTH: 608

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Pichia pastoris

&lt;400&gt; SEQUENCE: 45

Met	Ser	Ser	Lys	His	Trp	Asp	Tyr	Lys	Lys	Asp	Leu	Val	Leu	Ser	His		
1				5					10					15			
Leu	Ala	Gly	Leu	Cys	Gln	Ser	Asn	Pro	His	Val	Arg	Leu	Ile	Glu	Ser		
			20					25					30				
Glu	Arg	Val	Val	Ile	Ser	Ala	Glu	Asn	Gln	Glu	Asp	Lys	Ile	Thr	Leu		
		35					40					45					
Ile	Ser	Gly	Gly	Gly	Ser	Gly	His	Glu	Pro	Leu	His	Ala	Gly	Phe	Val		
	50					55					60						
Thr	Lys	Asp	Gly	Leu	Leu	Asp	Ala	Ala	Val	Ala	Gly	Phe	Ile	Phe	Ala		
65					70					75					80		
Ser	Pro	Ser	Thr	Lys	Gln	Ile	Phe	Ser	Ala	Ile	Lys	Ala	Lys	Pro	Ser		
				85					90					95			
Lys	Lys	Gly	Thr	Leu	Ile	Ile	Val	Lys	Asn	Tyr	Thr	Gly	Asp	Ile	Leu		
			100					105					110				
His	Phe	Gly	Leu	Ala	Ala	Glu	Lys	Ala	Lys	Ala	Glu	Gly	Leu	Asn	Ala		
		115					120					125					
Glu	Leu	Leu	Ile	Val	Gln	Asp	Asp	Val	Ser	Val	Gly	Lys	Ala	Lys	Asn		
	130					135					140						
Gly	Leu	Val	Gly	Arg	Arg	Gly	Leu	Ala	Gly	Thr	Ser	Leu	Val	His	Lys		
145					150					155					160		
Ile	Leu	Gly	Ala	Lys	Ala	Tyr	Leu	Gln	Lys	Asp	Asn	Leu	Glu	Leu	His		
				165					170					175			
Gln	Leu	Val	Thr	Phe	Gly	Glu	Lys	Val	Val	Ala	Asn	Leu	Val	Thr	Ile		
			180					185					190				
Gly	Ala	Ser	Leu	Asp	His	Val	Thr	Ile	Pro	Ala	Arg	Ala	Asn	Lys	Gln		
		195					200					205					
Glu	Glu	Asp	Asp	Ser	Asp	Asp	Glu	His	Gly	Tyr	Glu	Val	Leu	Lys	His		
	210					215					220						
Asp	Glu	Phe	Glu	Ile	Gly	Met	Gly	Ile	His	Asn	Glu	Pro	Gly	Ile	Lys		
225					230					235					240		
Lys	Ser	Ser	Pro	Ile	Pro	Thr	Val	Asp	Glu	Leu	Val	Ala	Glu	Leu	Leu		
				245					250					255			

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Glu Tyr Leu Leu Ser Thr Thr Asp Lys Asp Arg Asn Tyr Val Gln Phe  
                   260                  265                  270  
 Asp Lys Asn Asp Glu Val Val Leu Leu Ile Asn Asn Leu Gly Gly Thr  
                   275                  280                  285  
 Ser Val Leu Glu Leu Tyr Ala Ile Gln Asn Ile Val Val Asp Gln Leu  
                   290                  295                  300  
 Ala Ser Lys Tyr Ser Ile Lys Pro Val Arg Ile Phe Thr Gly Thr Phe  
                   305                  310                  315                  320  
 Thr Thr Ser Leu Asp Gly Pro Gly Phe Ser Ile Thr Leu Leu Asn Ala  
                   325                  330                  335  
 Thr Lys Thr Gly Asp Lys Asp Ile Leu Lys Phe Leu Asp His Lys Thr  
                   340                  345                  350  
 Ser Ala Pro Gly Trp Asn Ser Asn Ile Ser Asp Trp Ser Gly Arg Val  
                   355                  360                  365  
 Asp Asn Phe Ile Val Ala Ala Pro Glu Ile Asp Glu Gly Asp Ser Ser  
                   370                  375                  380  
 Ser Lys Val Ser Val Asp Ala Lys Leu Tyr Ala Asp Leu Leu Glu Ser  
                   385                  390                  395                  400  
 Gly Val Lys Lys Val Ile Ser Lys Glu Pro Lys Ile Thr Leu Tyr Asp  
                   405                  410                  415  
 Thr Val Ala Gly Asp Gly Asp Cys Gly Glu Thr Leu Ala Asn Gly Ser  
                   420                  425                  430  
 Asn Ala Ile Leu Lys Ala Leu Ala Glu Gly Lys Leu Asp Leu Lys Asp  
                   435                  440                  445  
 Gly Val Lys Ser Leu Val Gln Ile Thr Asp Ile Val Glu Thr Ala Met  
                   450                  455                  460  
 Gly Gly Thr Ser Gly Gly Leu Tyr Ser Ile Phe Ile Ser Ala Leu Ala  
                   465                  470                  475                  480  
 Lys Ser Leu Lys Glu Lys Glu Leu Ser Glu Gly Ala Tyr Thr Leu Thr  
                   485                  490                  495  
 Leu Glu Thr Ile Ser Gly Ser Leu Gln Ala Ala Leu Gln Ser Leu Phe  
                   500                  505                  510  
 Lys Tyr Thr Arg Ala Arg Thr Gly Asp Arg Thr Leu Ile Asp Ala Leu  
                   515                  520                  525  
 Glu Pro Phe Val Lys Glu Phe Ala Lys Ser Lys Asp Leu Lys Leu Ala  
                   530                  535                  540  
 Asn Lys Ala Ala His Asp Gly Ala Glu Ala Thr Arg Lys Leu Glu Ala  
                   545                  550                  555                  560  
 Lys Phe Gly Arg Ala Ser Tyr Val Ala Glu Glu Glu Phe Lys Gln Phe  
                   565                  570                  575  
 Glu Ser Glu Gly Gly Leu Pro Asp Pro Gly Ala Ile Gly Leu Ala Ala  
                   580                  585                  590  
 Leu Ile Ser Gly Ile Thr Asp Ala Tyr Phe Lys Ser Glu Thr Lys Leu  
                   595                  600                  605

<210> SEQ ID NO 46  
 <211> LENGTH: 1824  
 <212> TYPE: DNA  
 <213> ORGANISM: Debaryomyces hansenii  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1824)

<400> SEQUENCE: 46

atg tcg tta gct aaa cac tgg gga tac tca aag gat ttg gtt ttg gaa  
 Met Ser Leu Ala Lys His Trp Gly Tyr Ser Lys Asp Leu Val Leu Glu



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1	5	10	15	
aat tta aag ggt ttg gct gct gca aac ccc aaa att tct ctt ata cca				96
Asn Leu Lys Gly Leu Ala Ala Ala Asn Pro Lys Ile Ser Leu Ile Pro	20	25	30	
gca gaa aaa aca gtc gtg tat aat gat tcc tta caa tct aaa gga aac				144
Ala Glu Lys Thr Val Val Tyr Asn Asp Ser Leu Gln Ser Lys Gly Asn	35	40	45	
aag aat att aat cgt ata atg gtt att tct gga gga ggt tca ggc cat				192
Lys Asn Ile Asn Arg Ile Met Val Ile Ser Gly Gly Gly Ser Gly His	50	55	60	
gaa ccg tta cat gcg gga ttt gtt ggt gta aat gca tta gat gct gct				240
Glu Pro Leu His Ala Gly Phe Val Gly Val Asn Ala Leu Asp Ala Ala	65	70	75	80
gta tct ggt tca ata ttt gcc tcc cct tca gcc aag cag att ttt gca				288
Val Ser Gly Ser Ile Phe Ala Ser Pro Ser Ala Lys Gln Ile Phe Ala	85	90	95	
gcc att aag tca att agc tcc aaa caa aac aat tct aaa ggt act ttg				336
Ala Ile Lys Ser Ile Ser Ser Lys Gln Asn Asn Ser Lys Gly Thr Leu	100	105	110	
gta att gtc aaa aat tat aca gga gat gtt cta cat ttt gga ctt gct				384
Val Ile Val Lys Asn Tyr Thr Gly Asp Val Leu His Phe Gly Leu Ala	115	120	125	
gtc gaa aga gca aaa gca cat gcc tac aaa ata gac atg ata att gtt				432
Val Glu Arg Ala Lys Ala His Gly Tyr Lys Ile Asp Met Ile Ile Val	130	135	140	
ggt gat gac gca gct gta ggt agg tca aag ggt gga atg gtt gga aga				480
Gly Asp Asp Ala Ala Val Gly Arg Ser Lys Gly Gly Met Val Gly Arg	145	150	155	160
aga gca ttg gca gcc act gca ttg gtt cac aaa att gtt gga tct gct				528
Arg Ala Leu Ala Ala Thr Ala Leu Val His Lys Ile Val Gly Ser Ala	165	170	175	
gct tct gaa att gaa gat cta agc aga ctt aaa ata ttg ggt gat tcc				576
Ala Ser Glu Ile Glu Asp Leu Ser Arg Leu Lys Ile Leu Gly Asp Ser	180	185	190	
gtt gcg aat aat acg gtg acc att ggt gcc acc tta gat cat tgc tct				624
Val Ala Asn Asn Thr Val Thr Ile Gly Ala Thr Leu Asp His Cys Ser	195	200	205	
gtt cct ggg cgt gat att gca aac ttt gag cct att ggc cag aat gat				672
Val Pro Gly Arg Asp Ile Ala Asn Phe Glu Pro Ile Gly Gln Asn Asp	210	215	220	
gct gaa ata ggt cta ggg ata cat aac gaa act tcg gtc aag aag gta				720
Ala Glu Ile Gly Leu Gly Ile His Asn Glu Thr Ser Val Lys Lys Val	225	230	235	240
aac cct gta cca atg ata gac tca tta gtt cag gac tta tta gaa ttc				768
Asn Pro Val Pro Met Ile Asp Ser Leu Val Gln Asp Leu Leu Glu Phe	245	250	255	
cta tta aac gaa aat gac aaa gat cgt tac ttt gta cca ttt gat ctc				816
Leu Leu Asn Glu Asn Asp Lys Asp Arg Tyr Phe Val Pro Phe Asp Leu	260	265	270	
agt aat gat gaa acg gtc ttg ctt gtc aac aat ctc ggg ggt aca tct				864
Ser Asn Asp Glu Thr Val Leu Leu Val Asn Asn Leu Gly Gly Thr Ser	275	280	285	
act tta gaa atg tat gct att aca aat tgc gtt atc gaa aca tta tac				912
Thr Leu Glu Met Tyr Ala Ile Thr Asn Cys Val Ile Glu Thr Leu Tyr	290	295	300	
caa caa tac agt ttg aga cca aaa aaa gtg ata gtg gga gaa ttt gct				960
Gln Gln Tyr Ser Leu Arg Pro Lys Lys Val Ile Val Gly Glu Phe Ala	305	310	315	320
acg tct tta aat gcc cct ggg ttt tcg att acc tta ctt aac gtc tct				1008
Thr Ser Leu Asn Ala Pro Gly Phe Ser Ile Thr Leu Leu Asn Val Ser				

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325	330	335	
tgt gca tct aaa caa tcc caa att tcc att tca cat ata atg agt tac			1056
Cys Ala Ser Lys Gln Ser Gln Ile Ser Ile Ser His Ile Met Ser Tyr			
340	345	350	
ttg gat ttg cca aca gat gcc cct ggt tgg aag gca cat ccg tgt ggg			1104
Leu Asp Leu Pro Thr Asp Ala Pro Gly Trp Lys Ala His Pro Cys Gly			
355	360	365	
ttt gga ctt gaa aga gac atc aat att gag aca tca atc aat ggt att			1152
Phe Gly Leu Glu Arg Asp Ile Asn Ile Glu Thr Ser Ile Asn Gly Ile			
370	375	380	
gat tct ttt gtc aag tca caa tta aag ctt tcc aga gaa caa cag acg			1200
Asp Ser Phe Val Lys Ser Gln Leu Lys Leu Ser Arg Glu Gln Gln Thr			
385	390	395	400
gac ttt aga agc agt cta gtt aat ggg ttg gaa aaa tta tta gac aaa			1248
Asp Phe Arg Ser Ser Leu Val Asn Gly Leu Glu Lys Leu Leu Asp Lys			
405	410	415	
gaa cca agc att aca ttt tat gat act gtt gct ggt gat ggt gac tgt			1296
Glu Pro Ser Ile Thr Phe Tyr Asp Thr Val Ala Gly Asp Gly Asp Cys			
420	425	430	
ggt gaa acc tta gcg tct ggt gca aat gga ata ttg gaa tca tta agg			1344
Gly Glu Thr Leu Ala Ser Gly Ala Asn Gly Ile Leu Glu Ser Leu Arg			
435	440	445	
aac aac gaa atc tgc ttt gaa gat cca gtt tat tcc ata tct caa ata			1392
Asn Asn Glu Ile Cys Phe Glu Asp Pro Val Tyr Ser Ile Ser Gln Ile			
450	455	460	
gca aac att gta gag gat aaa atg ggc gga act tca gga ggc tta tat			1440
Ala Asn Ile Val Glu Asp Lys Met Gly Gly Thr Ser Gly Gly Leu Tyr			
465	470	475	480
tca att ttc tta acc tcg ttg ata aaa cac ctt caa gat tgt act aca			1488
Ser Ile Phe Leu Thr Ser Leu Ile Lys His Leu Gln Asp Cys Thr Thr			
485	490	495	
ttg aac tta tgt gaa atg ttt gct agt tct ttg cat aat gcg cta tat			1536
Leu Asn Leu Cys Glu Met Phe Ala Ser Ser Leu His Asn Ala Leu Tyr			
500	505	510	
cag ggc tta tat aaa tac act agg gca cga gtg ggt gga aga act ttg			1584
Gln Gly Leu Tyr Lys Tyr Thr Arg Ala Arg Val Gly Gly Arg Thr Leu			
515	520	525	
att gat gct tta gag ccg ttt gtg aat acc ttc aac gac act cta aat			1632
Ile Asp Ala Leu Glu Pro Phe Val Asn Thr Phe Asn Asp Thr Leu Asn			
530	535	540	
ttc tca aag gct gcc cag gct gct atc gat gga tct gaa tcg act agg			1680
Phe Ser Lys Ala Ala Gln Ala Ala Ile Asp Gly Ser Glu Ser Thr Arg			
545	550	555	560
aaa tta gct gca aaa ttt ggg aga gcg tct tat gtc aat gaa caa gaa			1728
Lys Leu Ala Ala Lys Phe Gly Arg Ala Ser Tyr Val Asn Glu Gln Glu			
565	570	575	
ttt aaa cag ttc gac gaa gaa gga ggc tta ccg gat ccg gga gct att			1776
Phe Lys Gln Phe Asp Glu Glu Gly Gly Leu Pro Asp Pro Gly Ala Ile			
580	585	590	
gga tta gcc acc tta att gct ggg ttt gcc ggt gtt gac tat aat taa			1824
Gly Leu Ala Thr Leu Ile Ala Gly Phe Ala Gly Val Asp Tyr Asn			
595	600	605	

<210> SEQ ID NO 47  
 <211> LENGTH: 607  
 <212> TYPE: PRT  
 <213> ORGANISM: Debaryomyces hansenii  
  
 <400> SEQUENCE: 47

Met Ser Leu Ala Lys His Trp Gly Tyr Ser Lys Asp Leu Val Leu Glu  
 1 5 10 15



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Asn Leu Lys Gly Leu Ala Ala Ala Asn Pro Lys Ile Ser Leu Ile Pro  
 20 25 30  
 Ala Glu Lys Thr Val Val Tyr Asn Asp Ser Leu Gln Ser Lys Gly Asn  
 35 40 45  
 Lys Asn Ile Asn Arg Ile Met Val Ile Ser Gly Gly Gly Ser Gly His  
 50 55 60  
 Glu Pro Leu His Ala Gly Phe Val Gly Val Asn Ala Leu Asp Ala Ala  
 65 70 75 80  
 Val Ser Gly Ser Ile Phe Ala Ser Pro Ser Ala Lys Gln Ile Phe Ala  
 85 90 95  
 Ala Ile Lys Ser Ile Ser Ser Lys Gln Asn Asn Ser Lys Gly Thr Leu  
 100 105 110  
 Val Ile Val Lys Asn Tyr Thr Gly Asp Val Leu His Phe Gly Leu Ala  
 115 120 125  
 Val Glu Arg Ala Lys Ala His Gly Tyr Lys Ile Asp Met Ile Ile Val  
 130 135 140  
 Gly Asp Asp Ala Ala Val Gly Arg Ser Lys Gly Gly Met Val Gly Arg  
 145 150 155 160  
 Arg Ala Leu Ala Ala Thr Ala Leu Val His Lys Ile Val Gly Ser Ala  
 165 170 175  
 Ala Ser Glu Ile Glu Asp Leu Ser Arg Leu Lys Ile Leu Gly Asp Ser  
 180 185 190  
 Val Ala Asn Asn Thr Val Thr Ile Gly Ala Thr Leu Asp His Cys Ser  
 195 200 205  
 Val Pro Gly Arg Asp Ile Ala Asn Phe Glu Pro Ile Gly Gln Asn Asp  
 210 215 220  
 Ala Glu Ile Gly Leu Gly Ile His Asn Glu Thr Ser Val Lys Lys Val  
 225 230 235 240  
 Asn Pro Val Pro Met Ile Asp Ser Leu Val Gln Asp Leu Leu Glu Phe  
 245 250 255  
 Leu Leu Asn Glu Asn Asp Lys Asp Arg Tyr Phe Val Pro Phe Asp Leu  
 260 265 270  
 Ser Asn Asp Glu Thr Val Leu Leu Val Asn Asn Leu Gly Gly Thr Ser  
 275 280 285  
 Thr Leu Glu Met Tyr Ala Ile Thr Asn Cys Val Ile Glu Thr Leu Tyr  
 290 295 300  
 Gln Gln Tyr Ser Leu Arg Pro Lys Lys Val Ile Val Gly Glu Phe Ala  
 305 310 315 320  
 Thr Ser Leu Asn Ala Pro Gly Phe Ser Ile Thr Leu Leu Asn Val Ser  
 325 330 335  
 Cys Ala Ser Lys Gln Ser Gln Ile Ser Ile Ser His Ile Met Ser Tyr  
 340 345 350  
 Leu Asp Leu Pro Thr Asp Ala Pro Gly Trp Lys Ala His Pro Cys Gly  
 355 360 365  
 Phe Gly Leu Glu Arg Asp Ile Asn Ile Glu Thr Ser Ile Asn Gly Ile  
 370 375 380  
 Asp Ser Phe Val Lys Ser Gln Leu Lys Leu Ser Arg Glu Gln Gln Thr  
 385 390 395 400  
 Asp Phe Arg Ser Ser Leu Val Asn Gly Leu Glu Lys Leu Leu Asp Lys  
 405 410 415  
 Glu Pro Ser Ile Thr Phe Tyr Asp Thr Val Ala Gly Asp Gly Asp Cys  
 420 425 430  
 Gly Glu Thr Leu Ala Ser Gly Ala Asn Gly Ile Leu Glu Ser Leu Arg

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435				440				445							
Asn	Asn	Glu	Ile	Cys	Phe	Glu	Asp	Pro	Val	Tyr	Ser	Ile	Ser	Gln	Ile
450						455					460				
Ala	Asn	Ile	Val	Glu	Asp	Lys	Met	Gly	Gly	Thr	Ser	Gly	Gly	Leu	Tyr
465					470					475					480
Ser	Ile	Phe	Leu	Thr	Ser	Leu	Ile	Lys	His	Leu	Gln	Asp	Cys	Thr	Thr
				485					490					495	
Leu	Asn	Leu	Cys	Glu	Met	Phe	Ala	Ser	Ser	Leu	His	Asn	Ala	Leu	Tyr
			500					505					510		
Gln	Gly	Leu	Tyr	Lys	Tyr	Thr	Arg	Ala	Arg	Val	Gly	Gly	Arg	Thr	Leu
		515					520					525			
Ile	Asp	Ala	Leu	Glu	Pro	Phe	Val	Asn	Thr	Phe	Asn	Asp	Thr	Leu	Asn
	530					535					540				
Phe	Ser	Lys	Ala	Ala	Gln	Ala	Ala	Ile	Asp	Gly	Ser	Glu	Ser	Thr	Arg
545					550					555					560
Lys	Leu	Ala	Ala	Lys	Phe	Gly	Arg	Ala	Ser	Tyr	Val	Asn	Glu	Gln	Glu
				565					570					575	
Phe	Lys	Gln	Phe	Asp	Glu	Glu	Gly	Gly	Leu	Pro	Asp	Pro	Gly	Ala	Ile
			580					585					590		
Gly	Leu	Ala	Thr	Leu	Ile	Ala	Gly	Phe	Ala	Gly	Val	Asp	Tyr	Asn	
		595					600					605			

<210> SEQ ID NO 48  
 <211> LENGTH: 1752  
 <212> TYPE: DNA  
 <213> ORGANISM: Escherichia blattae  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1752)

<400> SEQUENCE: 48

atg gtc tgc ccg cca gac ctt aac tca caa cct ttt act tcc cga cac	48
Met Val Cys Pro Pro Asp Leu Asn Ser Gln Pro Phe Thr Ser Arg His	
1 5 10 15	
acg cgc tac agc ccg ctg tac ggg tgt gtt gta cct aac gat cag gaa	96
Thr Arg Tyr Ser Pro Leu Tyr Gly Cys Val Val Pro Asn Asp Gln Glu	
20 25 30	
acc gtt atg tcg caa ttt ttt tat aac caa cgc gaa aat ctt gtc agt	144
Thr Val Met Ser Gln Phe Phe Tyr Asn Gln Arg Glu Asn Leu Val Ser	
35 40 45	
gac gcc atc gaa ggg gca atg att gcc agc ccg tgg aac aac ctg gcc	192
Asp Ala Ile Glu Gly Ala Met Ile Ala Ser Pro Trp Asn Asn Leu Ala	
50 55 60	
cgt ctg gag agc gat ccc gcc atc cgc atc gtg gtg cgc cgg gat ctg	240
Arg Leu Glu Ser Asp Pro Ala Ile Arg Ile Val Val Arg Arg Asp Leu	
65 70 75 80	
gat aaa tcc cgg gtg gcg gtg atc tcc ggg ggc ggt gcc ggt cac gaa	288
Asp Lys Ser Arg Val Ala Val Ile Ser Gly Gly Gly Ala Gly His Glu	
85 90 95	
ccg gcc cat gtg ggc ttt gtg ggt aaa ggc atg ctg acc gcc gcc gtg	336
Pro Ala His Val Gly Phe Val Gly Lys Gly Met Leu Thr Ala Ala Val	
100 105 110	
tgt ggt gat ctg ttt gcc tca ccg agc gtg gat gcg gtg ctt acc gcc	384
Cys Gly Asp Leu Phe Ala Ser Pro Ser Val Asp Ala Val Leu Thr Ala	
115 120 125	
att cag gcg gtc acc ggc gag gcg ggc tgc ctg ctg att gtc aaa aac	432
Ile Gln Ala Val Thr Gly Glu Ala Gly Cys Leu Leu Ile Val Lys Asn	
130 135 140	
tac acc ggt gac cgg ctg aac ttc ggg ctg gca gca gag aaa gcc cgg	480



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Tyr	Thr	Gly	Asp	Arg	Leu	Asn	Phe	Gly	Leu	Ala	Ala	Glu	Lys	Ala	Arg		
145					150					155					160		
cgc	atg	ggc	tac	aaa	gtg	gac	atg	gtg	att	gtg	ggg	gat	gat	atc	tca	528	
Arg	Met	Gly	Tyr	Lys	Val	Asp	Met	Val	Ile	Val	Gly	Asp	Asp	Ile	Ser		
				165					170					175			
ctg	ccg	gag	aac	aaa	cac	ccg	cgc	ggc	att	gcc	ggg	acg	att	atg	atc	576	
Leu	Pro	Glu	Asn	Lys	His	Pro	Arg	Gly	Ile	Ala	Gly	Thr	Ile	Met	Ile		
				180					185					190			
cac	aaa	gtg	gcg	ggg	tac	ttc	gcc	gaa	acc	ggc	tgc	aac	ctg	gac	acg	624	
His	Lys	Val	Ala	Gly	Tyr	Phe	Ala	Glu	Thr	Gly	Cys	Asn	Leu	Asp	Thr		
				195			200						205				
gtc	gcc	cgg	gaa	gcc	cgg	ctg	gca	atg	gag	cgg	gta	ttc	agt	att	ggc	672	
Val	Ala	Arg	Glu	Ala	Arg	Leu	Ala	Met	Glu	Arg	Val	Phe	Ser	Ile	Gly		
				210			215					220					
gtg	gcc	ctt	tcc	agc	tgc	cac	tta	ccg	gcc	gat	ccg	cag	gat	ggc	gtg	720	
Val	Ala	Leu	Ser	Ser	Cys	His	Leu	Pro	Ala	Asp	Pro	Gln	Asp	Gly	Val		
					230					235					240		
cgc	cat	cac	ccg	ggc	cag	gct	gag	ctg	ggc	atg	ggg	atc	cac	ggg	gag	768	
Arg	His	His	Pro	Gly	Gln	Ala	Glu	Leu	Gly	Met	Gly	Ile	His	Gly	Glu		
				245						250				255			
ccc	ggc	gca	agc	gtc	atc	gac	acc	cag	aac	agc	acc	gac	att	gtg	cgc	816	
Pro	Gly	Ala	Ser	Val	Ile	Asp	Thr	Gln	Asn	Ser	Thr	Asp	Ile	Val	Arg		
				260					265				270				
ctg	atg	gtg	gca	aaa	atc	cgc	gct	gcc	ctg	cct	gaa	acc	ggc	cgc	ctg	864	
Leu	Met	Val	Ala	Lys	Ile	Arg	Ala	Ala	Leu	Pro	Glu	Thr	Gly	Arg	Leu		
				275				280					285				
ctg	ctg	atg	ctg	aat	aac	ctt	ggc	ggc	gtc	tca	gtc	acc	gaa	atg	gcg	912	
Leu	Leu	Met	Leu	Asn	Asn	Leu	Gly	Gly	Val	Ser	Val	Thr	Glu	Met	Ala		
				290			295					300					
atc	ctc	acc	cgg	gag	ctg	gcc	cac	tgt	gag	ctt	gcc	acc	cgc	acc	gac	960	
Ile	Leu	Thr	Arg	Glu	Leu	Ala	His	Cys	Glu	Leu	Ala	Thr	Arg	Thr	Asp		
					310					315					320		
tgg	ttg	atg	ggc	ccg	gca	ccg	ctg	gtc	agc	gcc	ctg	gac	atg	aaa	ggc	1008	
Trp	Leu	Met	Gly	Pro	Ala	Pro	Leu	Val	Ser	Ala	Leu	Asp	Met	Lys	Gly		
				325						330				335			
ttt	tcc	atc	acc	gcc	ctg	gtc	atg	gaa	gag	agc	att	gaa	aaa	gcc	ctg	1056	
Phe	Ser	Ile	Thr	Ala	Leu	Val	Met	Glu	Glu	Ser	Ile	Glu	Lys	Ala	Leu		
				340					345				350				
ctg	gca	gac	gtg	gaa	acc	gca	ggc	tgg	ctg	ccg	cca	gtg	cgc	ctg	cgc	1104	
Leu	Ala	Asp	Val	Glu	Thr	Ala	Gly	Trp	Leu	Pro	Pro	Val	Arg	Leu	Arg		
				355			360					365					
gcc	agc	cag	acc	cag	ccc	tgc	aat	atc	cgc	agt	gcc	cgg	gtg	gca	ttc	1152	
Ala	Ser	Gln	Thr	Gln	Pro	Cys	Asn	Ile	Arg	Ser	Ala	Arg	Val	Ala	Phe		
				370			375				380						
acc	ccg	tca	gac	aac	ccg	gta	gtg	ggc	cag	tat	gtg	gag	acc	gtc	acc	1200	
Thr	Pro	Ser	Asp	Asn	Pro	Val	Val	Gly	Gln	Tyr	Val	Glu	Thr	Val	Thr		
					390					395				400			
gcc	aca	ctc	agc	gcc	cag	gaa	gcg	gaa	ctt	aac	gcc	ctg	gat	gcc	aaa	1248	
Ala	Thr	Leu	Ser	Ala	Gln	Glu	Ala	Glu	Leu	Asn	Ala	Leu	Asp	Ala	Lys		
				405					410				415				
gtg	ggc	gac	ggc	gat	acc	ggc	tcc	acc	ttt	gcc	gcc	ggg	gcc	cgc	gcc	1296	
Val	Gly	Asp	Gly	Asp	Thr	Gly	Ser	Thr	Phe	Ala	Ala	Gly	Ala	Arg	Ala		
				420				425					430				
att	gca	gaa	ctg	ctg	cac	cag	cac	cag	ctg	ccg	ctc	agc	cag	ctg	gat	1344	
Ile	Ala	Glu	Leu	Leu	His	Gln	His	Gln	Leu	Pro	Leu	Ser	Gln	Leu	Asp		
				435				440				445					
acc	ctg	tgc	gcc	ctg	atc	ggc	gaa	cgc	tta	aca	gta	gtg	atg	ggg	ggc	1392	
Thr	Leu	Cys	Ala	Leu	Ile	Gly	Glu	Arg	Leu	Thr	Val	Val	Met	Gly	Gly		
				450			455				460						
tcc	agc	ggt	gtg	ctg	atg	tcc	atc	ttc	ttt	acg	gcc	gca	ggc	cag	gca	1440	





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Val Ala Leu Ser Ser Cys His Leu Pro Ala Asp Pro Gln Asp Gly Val  
 225 230 235 240  
 Arg His His Pro Gly Gln Ala Glu Leu Gly Met Gly Ile His Gly Glu  
 245 250 255  
 Pro Gly Ala Ser Val Ile Asp Thr Gln Asn Ser Thr Asp Ile Val Arg  
 260 265 270  
 Leu Met Val Ala Lys Ile Arg Ala Ala Leu Pro Glu Thr Gly Arg Leu  
 275 280 285  
 Leu Leu Met Leu Asn Asn Leu Gly Gly Val Ser Val Thr Glu Met Ala  
 290 295 300  
 Ile Leu Thr Arg Glu Leu Ala His Cys Glu Leu Ala Thr Arg Thr Asp  
 305 310 315 320  
 Trp Leu Met Gly Pro Ala Pro Leu Val Ser Ala Leu Asp Met Lys Gly  
 325 330 335  
 Phe Ser Ile Thr Ala Leu Val Met Glu Glu Ser Ile Glu Lys Ala Leu  
 340 345 350  
 Leu Ala Asp Val Glu Thr Ala Gly Trp Leu Pro Pro Val Arg Leu Arg  
 355 360 365  
 Ala Ser Gln Thr Gln Pro Cys Asn Ile Arg Ser Ala Arg Val Ala Phe  
 370 375 380  
 Thr Pro Ser Asp Asn Pro Val Val Gly Gln Tyr Val Glu Thr Val Thr  
 385 390 395 400  
 Ala Thr Leu Ser Ala Gln Glu Ala Glu Leu Asn Ala Leu Asp Ala Lys  
 405 410 415  
 Val Gly Asp Gly Asp Thr Gly Ser Thr Phe Ala Ala Gly Ala Arg Ala  
 420 425 430  
 Ile Ala Glu Leu Leu His Gln His Gln Leu Pro Leu Ser Gln Leu Asp  
 435 440 445  
 Thr Leu Cys Ala Leu Ile Gly Glu Arg Leu Thr Val Val Met Gly Gly  
 450 455 460  
 Ser Ser Gly Val Leu Met Ser Ile Phe Phe Thr Ala Ala Gly Gln Ala  
 465 470 475 480  
 Ile Ser Glu Gly Lys Pro Val Val Ala Ala Leu Gln Ala Gly Leu Ala  
 485 490 495  
 Gln Met Lys Tyr Tyr Gly Gly Ala Asp Leu Gly Asp Arg Thr Leu Ile  
 500 505 510  
 Asp Ala Leu Gln Pro Ala Leu Ala Ala Leu Ala Gln His Pro Gly Asp  
 515 520 525  
 Leu Ala Ala Ala Tyr Gln Ala Ala Arg Asp Gly Ala Asp Ala Thr Thr  
 530 535 540  
 Arg Ala Thr Lys Ala Asn Ala Gly Arg Ala Ser Tyr Leu Asn Ser Asp  
 545 550 555 560  
 Ser Leu Ala Gly Asn Met Asp Pro Gly Ala His Ala Val Ala Met Val  
 565 570 575  
 Phe Lys Ala Leu Ala Gly Ala  
 580

<210> SEQ ID NO 50  
 <211> LENGTH: 1647  
 <212> TYPE: DNA  
 <213> ORGANISM: Enterobacter sp.638  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1647)  
 <400> SEQUENCE: 50

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atg tcc aga ttc ttt ttt aat gac cgc aaa cag ctg gtc aac gac gcc	48
Met Ser Arg Phe Phe Phe Asn Asp Arg Lys Gln Leu Val Asn Asp Ala	
1 5 10 15	
att gaa ggc ata ctg att tcc gcg ccg cac ggg aat ctt gtc aaa ctt	96
Ile Glu Gly Ile Leu Ile Ser Ala Pro His Gly Asn Leu Val Lys Leu	
20 25 30	
gat atc gat ccg gcc att cgg gtg gtt gcg cgt agc gac tgg gat aaa	144
Asp Ile Asp Pro Ala Ile Arg Val Val Ala Arg Ser Asp Trp Asp Lys	
35 40 45	
agc cgc gta gcg gtg att tcc ggt ggt ggg tcg ggg cac gaa ccc gct	192
Ser Arg Val Ala Val Ile Ser Gly Gly Gly Ser Gly His Glu Pro Ala	
50 55 60	
cat gcc gga ttt gtc ggc aaa ggg atg ttg acc gca gcc gtc tgt ggc	240
His Ala Gly Phe Val Gly Lys Gly Met Leu Thr Ala Ala Val Cys Gly	
65 70 75 80	
gat ctg ttt gcc tca ccg agc gta gat gcg gtg tta aac gcg att gtg	288
Asp Leu Phe Ala Ser Pro Ser Val Asp Ala Val Leu Asn Ala Ile Val	
85 90 95	
gcg gta acg ggc gat cgc ggt tgc ctg tta atc gtc aaa aat tat acc	336
Ala Val Thr Gly Asp Arg Gly Cys Leu Leu Ile Val Lys Asn Tyr Thr	
100 105 110	
ggc gat cgg ctt aac ttt ggc ctc gcg gcg gaa aag gcc aaa cgc tat	384
Gly Asp Arg Leu Asn Phe Gly Leu Ala Ala Glu Lys Ala Lys Arg Tyr	
115 120 125	
ggg ctg aag gtt gag atg gtg att gtt gct gat gac atc gcc ctg ccg	432
Gly Leu Lys Val Glu Met Val Ile Val Ala Asp Asp Ile Ala Leu Pro	
130 135 140	
gat aac aaa cag ccg cgt ggc att gcg ggt acg gcg ctg gta cac aaa	480
Asp Asn Lys Gln Pro Arg Gly Ile Ala Gly Thr Ala Leu Val His Lys	
145 150 155 160	
att gcc gga tat gca gcc gaa cag ggg aaa tca ctg gct gac gtg cgg	528
Ile Ala Gly Tyr Ala Ala Glu Gln Gly Lys Ser Leu Ala Asp Val Arg	
165 170 175	
gat att gcg cag cag gcc tgt gac aat atc tgg agc ctg ggc gtg gcg	576
Asp Ile Ala Gln Gln Ala Cys Asp Asn Ile Trp Ser Leu Gly Val Ala	
180 185 190	
atg caa acg tgc aac ctg ccg ggc agc gac gat gaa gaa ggg cgt atc	624
Met Gln Thr Cys Asn Leu Pro Gly Ser Asp Asp Glu Glu Gly Arg Ile	
195 200 205	
aag gat gga cat gtc gaa ctg ggg ctg ggc att cac ggc gag ccg ggc	672
Lys Asp Gly His Val Glu Leu Gly Leu Gly Ile His Gly Glu Pro Gly	
210 215 220	
gcg tcg gtg gtt gat acg cac aac agc aaa gag att atc gac acc ctg	720
Ala Ser Val Val Asp Thr His Asn Ser Lys Glu Ile Ile Asp Thr Leu	
225 230 235 240	
gtg aag ccg tta aaa gag acg gcc ggc gaa ggc aaa ttt gcg gtg ctg	768
Val Lys Pro Leu Lys Glu Thr Ala Gly Glu Gly Lys Phe Ala Val Leu	
245 250 255	
att aac aat ctc ggc ggt gta tcg gcg ctg gag atg gcg ctg ctc acg	816
Ile Asn Asn Leu Gly Gly Val Ser Ala Leu Glu Met Ala Leu Leu Thr	
260 265 270	
aaa gaa ctg gcg gat tct gcg ctg aaa gaa aat att gcg tat ctg att	864
Lys Glu Leu Ala Asp Ser Ala Leu Lys Glu Asn Ile Ala Tyr Leu Ile	
275 280 285	
ggc cct gcg ccg ctg gta agc tcg ctg gat atg aaa ggc ttt tcg ctg	912
Gly Pro Ala Pro Leu Val Ser Ser Leu Asp Met Lys Gly Phe Ser Leu	
290 295 300	
tca ctg tta cag ctt aac gat acc ttt gag aaa gcc att aac gca ccc	960
Ser Leu Leu Gln Leu Asn Asp Thr Phe Glu Lys Ala Ile Asn Ala Pro	
305 310 315 320	



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gtc gaa act atc ggc tgg caa aag ccg gta gca ttc gcg cca tta cgc 1008
Val Glu Thr Ile Gly Trp Gln Lys Pro Val Ala Phe Ala Pro Leu Arg
          325          330          335

acg ctt tcg cat act gcg att cag gat cgt gtt gaa ttt acg cct tcc 1056
Thr Leu Ser His Thr Ala Ile Gln Asp Arg Val Glu Phe Thr Pro Ser
          340          345          350

ggg aac gac gag gtc gca gcg cga gtg gca gcg gcg acg caa acg ttg 1104
Gly Asn Asp Glu Val Ala Ala Arg Val Ala Ala Ala Thr Gln Thr Leu
          355          360          365

ctc gct ctg gag aac cgt tta aat gcg ctg gac gcc aaa gtg ggc gac 1152
Leu Ala Leu Glu Asn Arg Leu Asn Ala Leu Asp Ala Lys Val Gly Asp
          370          375          380

ggc gat acc ggg tcg act ttt gcg caa ggc gcg cgg gaa att gcg cag 1200
Gly Asp Thr Gly Ser Thr Phe Ala Gln Gly Ala Arg Glu Ile Ala Gln
385          390          395          400

ctt ctg gag caa aaa cag ctt ccg cta aac gat ctt tct aag ctg ctg 1248
Leu Leu Glu Gln Lys Gln Leu Pro Leu Asn Asp Leu Ser Lys Leu Leu
          405          410          415

ttg ttg atc ggc gaa cgg ctg gcg acg gtc atg ggc ggg tcg agt ggc 1296
Leu Leu Ile Gly Glu Arg Leu Ala Thr Val Met Gly Gly Ser Ser Gly
          420          425          430

gtc ctg atg tcg atc ttc ttc aca gct gcc gga cag aaa atg cat gac 1344
Val Leu Met Ser Ile Phe Phe Thr Ala Ala Gly Gln Lys Met His Asp
          435          440          445

gga aaa tca ctg ccg gag gca ttg ctg agt ggg ctt gcg caa atg aag 1392
Gly Lys Ser Leu Pro Glu Ala Leu Leu Ser Gly Leu Ala Gln Met Lys
          450          455          460

cat tac ggc gga gcg gat ctt ggc gat cgt acc ttg atc gac gcg cta 1440
His Tyr Gly Gly Ala Asp Leu Gly Asp Arg Thr Leu Ile Asp Ala Leu
465          470          475          480

cag cct gca ctg gag acg ctg cat aac ggc gat att cag gcg gct gcc 1488
Gln Pro Ala Leu Glu Thr Leu His Asn Gly Asp Ile Gln Ala Ala Ala
          485          490          495

cag gca gcg aaa aaa ggc gca gac gct acg gct ggc atg caa aaa gcg 1536
Gln Ala Ala Lys Lys Gly Ala Asp Ala Thr Ala Gly Met Gln Lys Ala
          500          505          510

gga gca ggg cgt tcg tcg tat gtg aat aaa gag aac ctg gaa ggt gta 1584
Gly Ala Gly Arg Ser Ser Tyr Val Asn Lys Glu Asn Leu Glu Gly Val
          515          520          525

ata gat cct ggg gca gtg gcc gtt gca gag gtg ttt gcg gca gtg gcc 1632
Ile Asp Pro Gly Ala Val Ala Val Ala Glu Val Phe Ala Ala Val Ala
          530          535          540

aaa gca aaa cag tag 1647
Lys Ala Lys Gln
545

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<210> SEQ ID NO 51
<211> LENGTH: 548
<212> TYPE: PRT
<213> ORGANISM: Enterobacter sp.638

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<400> SEQUENCE: 51

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Met Ser Arg Phe Phe Phe Asn Asp Arg Lys Gln Leu Val Asn Asp Ala
1          5          10          15

Ile Glu Gly Ile Leu Ile Ser Ala Pro His Gly Asn Leu Val Lys Leu
20          25          30

Asp Ile Asp Pro Ala Ile Arg Val Val Ala Arg Ser Asp Trp Asp Lys
35          40          45

Ser Arg Val Ala Val Ile Ser Gly Gly Gly Ser Gly His Glu Pro Ala
50          55          60

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His Ala Gly Phe Val Gly Lys Gly Met Leu Thr Ala Ala Val Cys Gly  
 65 70 75 80  
 Asp Leu Phe Ala Ser Pro Ser Val Asp Ala Val Leu Asn Ala Ile Val  
 85 90 95  
 Ala Val Thr Gly Asp Arg Gly Cys Leu Leu Ile Val Lys Asn Tyr Thr  
 100 105 110  
 Gly Asp Arg Leu Asn Phe Gly Leu Ala Ala Glu Lys Ala Lys Arg Tyr  
 115 120 125  
 Gly Leu Lys Val Glu Met Val Ile Val Ala Asp Asp Ile Ala Leu Pro  
 130 135 140  
 Asp Asn Lys Gln Pro Arg Gly Ile Ala Gly Thr Ala Leu Val His Lys  
 145 150 155 160  
 Ile Ala Gly Tyr Ala Ala Glu Gln Gly Lys Ser Leu Ala Asp Val Arg  
 165 170 175  
 Asp Ile Ala Gln Gln Ala Cys Asp Asn Ile Trp Ser Leu Gly Val Ala  
 180 185 190  
 Met Gln Thr Cys Asn Leu Pro Gly Ser Asp Asp Glu Glu Gly Arg Ile  
 195 200 205  
 Lys Asp Gly His Val Glu Leu Gly Leu Gly Ile His Gly Glu Pro Gly  
 210 215 220  
 Ala Ser Val Val Asp Thr His Asn Ser Lys Glu Ile Ile Asp Thr Leu  
 225 230 235 240  
 Val Lys Pro Leu Lys Glu Thr Ala Gly Glu Gly Lys Phe Ala Val Leu  
 245 250 255  
 Ile Asn Asn Leu Gly Gly Val Ser Ala Leu Glu Met Ala Leu Leu Thr  
 260 265 270  
 Lys Glu Leu Ala Asp Ser Ala Leu Lys Glu Asn Ile Ala Tyr Leu Ile  
 275 280 285  
 Gly Pro Ala Pro Leu Val Ser Ser Leu Asp Met Lys Gly Phe Ser Leu  
 290 295 300  
 Ser Leu Leu Gln Leu Asn Asp Thr Phe Glu Lys Ala Ile Asn Ala Pro  
 305 310 315 320  
 Val Glu Thr Ile Gly Trp Gln Lys Pro Val Ala Phe Ala Pro Leu Arg  
 325 330 335  
 Thr Leu Ser His Thr Ala Ile Gln Asp Arg Val Glu Phe Thr Pro Ser  
 340 345 350  
 Gly Asn Asp Glu Val Ala Ala Arg Val Ala Ala Ala Thr Gln Thr Leu  
 355 360 365  
 Leu Ala Leu Glu Asn Arg Leu Asn Ala Leu Asp Ala Lys Val Gly Asp  
 370 375 380  
 Gly Asp Thr Gly Ser Thr Phe Ala Gln Gly Ala Arg Glu Ile Ala Gln  
 385 390 395 400  
 Leu Leu Glu Gln Lys Gln Leu Pro Leu Asn Asp Leu Ser Lys Leu Leu  
 405 410 415  
 Leu Leu Ile Gly Glu Arg Leu Ala Thr Val Met Gly Gly Ser Ser Gly  
 420 425 430  
 Val Leu Met Ser Ile Phe Phe Thr Ala Ala Gly Gln Lys Met His Asp  
 435 440 445  
 Gly Lys Ser Leu Pro Glu Ala Leu Leu Ser Gly Leu Ala Gln Met Lys  
 450 455 460  
 His Tyr Gly Gly Ala Asp Leu Gly Asp Arg Thr Leu Ile Asp Ala Leu  
 465 470 475 480  
 Gln Pro Ala Leu Glu Thr Leu His Asn Gly Asp Ile Gln Ala Ala Ala



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485				490				495								
Gln	Ala	Ala	Lys	Lys	Gly	Ala	Asp	Ala	Thr	Ala	Gly	Met	Gln	Lys	Ala	
			500												510	
Gly	Ala	Gly	Arg	Ser	Ser	Tyr	Val	Asn	Lys	Glu	Asn	Leu	Glu	Gly	Val	
			515				520								525	
Ile	Asp	Pro	Gly	Ala	Val	Ala	Val	Ala	Glu	Val	Phe	Ala	Ala	Val	Ala	
			530				535								540	
Lys	Ala	Lys	Gln													
			545													
<210> SEQ ID NO 52																
<211> LENGTH: 1695																
<212> TYPE: DNA																
<213> ORGANISM: Psychromonas sp. CNPT3																
<220> FEATURE:																
<221> NAME/KEY: CDS																
<222> LOCATION: (1)..(1695)																
<400> SEQUENCE: 52																
atg	ggt	ata	tta	ttt	ttt	aac	cta	ctt	tat	ttt	aaa	cta	ctt	ttt	gga	48
Met	Val	Ile	Leu	Phe	Phe	Asn	Leu	Leu	Tyr	Phe	Lys	Leu	Leu	Phe	Gly	
1				5					10					15		
gta	att	atg	agc	cgt	tta	ttt	att	aat	gat	aaa	gca	acg	tta	gtc	cat	96
Val	Ile	Met	Ser	Arg	Leu	Phe	Ile	Asn	Asp	Lys	Ala	Thr	Leu	Val	His	
			20				25							30		
gat	gcg	att	gat	ggc	atc	tta	tat	agc	aat	aag	cat	aat	aac	ctt	gtt	144
Asp	Ala	Ile	Asp	Gly	Ile	Leu	Tyr	Ser	Asn	Lys	His	Asn	Asn	Leu	Val	
			35				40							45		
cgt	ttg	gat	ggt	gat	ccg	caa	att	aga	att	gtg	acg	cgt	aat	gat	tgg	192
Arg	Leu	Asp	Val	Asp	Pro	Gln	Ile	Arg	Ile	Val	Thr	Arg	Asn	Asp	Trp	
			50				55				60					
cat	cac	gat	aaa	ggt	gcc	att	atc	tct	ggt	ggt	ggc	tct	ggg	cat	gag	240
His	His	Asp	Lys	Val	Ala	Ile	Ile	Ser	Gly	Gly	Gly	Ser	Gly	His	Glu	
			65				70				75				80	
cct	gct	cat	ggt	ggt	ttt	att	ggt	aaa	ggt	atg	tta	acg	gct	gct	ggt	288
Pro	Ala	His	Val	Gly	Phe	Ile	Gly	Lys	Gly	Met	Leu	Thr	Ala	Ala	Val	
			85								90				95	
tgt	ggc	gat	ggt	ttt	gcc	tca	cca	agt	gtg	gat	gcg	gtg	tta	aat	gcc	336
Cys	Gly	Asp	Val	Phe	Ala	Ser	Pro	Ser	Val	Asp	Ala	Val	Leu	Asn	Ala	
			100											110		
ata	gtc	cat	gtc	aca	gga	gag	aaa	ggt	tgt	ttg	gtc	att	ggt	aaa	aac	384
Ile	Val	His	Val	Thr	Gly	Glu	Lys	Gly	Cys	Leu	Val	Ile	Val	Lys	Asn	
			115											120		
tat	acc	ggc	gac	cgt	ttg	aac	ttt	ggc	ctt	gct	tgt	gaa	aaa	gcc	aaa	432
Tyr	Thr	Gly	Asp	Arg	Leu	Asn	Phe	Gly	Leu	Ala	Cys	Glu	Lys	Ala	Lys	
			130				135							140		
aaa	atg	ggt	tta	aac	ggt	gaa	atg	gta	ata	gta	gac	gat	gat	atc	tct	480
Lys	Met	Gly	Leu	Asn	Val	Glu	Met	Val	Ile	Val	Asp	Asp	Asp	Ile	Ser	
			145				150				155				160	
att	cct	gac	aat	ctt	aaa	cct	cgt	ggt	att	gct	ggc	aca	ttg	ttt	gtc	528
Ile	Pro	Asp	Asn	Leu	Lys	Pro	Arg	Gly	Ile	Ala	Gly	Thr	Leu	Phe	Val	
			165								170				175	
cat	aaa	gtg	gca	ggt	aat	gca	gca	gag	caa	ggc	gct	tct	tta	aat	gtc	576
His	Lys	Val	Ala	Gly	Asn	Ala	Ala	Glu	Gln	Gly	Ala	Ser	Leu	Asn	Val	
			180								185				190	
ggt	aaa	aag	gca	gcc	caa	ggt	gcg	att	gat	gca	acg	gca	agt	att	ggc	624
Val	Lys	Lys	Ala	Ala	Gln	Gly	Ala	Ile	Asp	Ala	Thr	Ala	Ser	Ile	Gly	
			195				200								205	
ctc	gca	ctg	aca	agt	tgc	tct	tta	ccg	gga	gaa	gaa	tca	acg	cag	cgt	672
Leu	Ala	Leu	Thr	Ser	Cys	Ser	Leu	Pro	Gly	Glu	Glu	Ser	Thr	Gln	Arg	
			210				215								220	

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att gca gaa ggc aag gct gaa tta ggg tta ggt att cat gga gag cct Ile Ala Glu Gly Lys Ala Glu Leu Gly Leu Gly Ile His Gly Glu Pro 225 230 235 240	720
ggc att aaa aca att gat gta aca tgt tgt cgt gat ctt gtg atg atc Gly Ile Lys Thr Ile Asp Val Thr Cys Cys Arg Asp Leu Val Met Ile 245 250 255	768
atg gtt gat aaa cta aaa caa tcg ttt tct gct cca gat att aaa att Met Val Asp Lys Leu Lys Gln Ser Phe Ser Ala Pro Asp Ile Lys Ile 260 265 270	816
gca gtg atg atc aac aat tta ggt ggc gtt tct cca tta gag atg agc Ala Val Met Ile Asn Asn Leu Gly Gly Val Ser Pro Leu Glu Met Ser 275 280 285	864
ctt ata tgt aaa gac atc gtg gaa tct gag tta aaa aat aat att gag Leu Ile Cys Lys Asp Ile Val Glu Ser Glu Leu Lys Asn Asn Ile Glu 290 295 300	912
tta gtg gtt ggg cct gct cca ttt atg acg gct att gat atg aaa gga Leu Val Val Gly Pro Ala Pro Phe Met Thr Ala Ile Asp Met Lys Gly 305 310 315 320	960
ttt tca att tca gtg att gaa tta aca ggc gat cat gct caa gct ctg Phe Ser Ile Ser Val Ile Glu Leu Thr Gly Asp His Ala Gln Ala Leu 325 330 335	1008
tgc gcc cct gtt gaa gtg gat gca tgg gtt gaa gcc att cca ttg cgc Cys Ala Pro Val Glu Val Asp Ala Trp Val Glu Ala Ile Pro Leu Arg 340 345 350	1056
cca tta aat gtg ata aaa aaa gat aaa gtg tcc att aac ttt gca ttt Pro Leu Asn Val Ile Lys Lys Asp Lys Val Ser Ile Asn Phe Ala Phe 355 360 365	1104
gaa gcg tct gaa aat gca cag gtt gca agt att gtt aaa aca gta acc Glu Ala Ser Glu Asn Ala Gln Val Ala Ser Ile Val Lys Thr Val Thr 370 375 380	1152
ttg gct ttg att aat gca gaa aaa gag tta aat cgt ctg gat acg tta Leu Ala Leu Ile Asn Ala Glu Lys Glu Leu Asn Arg Leu Asp Thr Leu 385 390 395 400	1200
gtg ggc gat ggg gat acc ggt tca acg ttc tct gcg ggt gct cga caa Val Gly Asp Gly Asp Thr Gly Ser Thr Phe Ser Ala Gly Ala Arg Gln 405 410 415	1248
gtt tta gct gag ctc aat gcg ggt aat tta cca ctt aat gat act ggc Val Leu Ala Glu Leu Asn Ala Gly Asn Leu Pro Leu Asn Asp Thr Gly 420 425 430	1296
gcg ttg ctt aat gtc att ggg gaa caa ctt gct acc gtt atg ggg gga Ala Leu Leu Asn Val Ile Gly Glu Gln Leu Ala Thr Val Met Gly Gly 435 440 445	1344
tcg tca ggc gta tta ttc tct atc ttc ttc aca gca gcg ggt cat cat Ser Ser Gly Val Leu Phe Ser Ile Phe Phe Thr Ala Ala Gly His His 450 455 460	1392
tac cag caa cat ggt gat aca gta caa gca tta caa gcc ggt tta caa Tyr Gln Gln His Gly Asp Thr Val Gln Ala Leu Gln Ala Gly Leu Gln 465 470 475 480	1440
caa atg atg caa tac ggt gga gca aaa ccg ggt gat cgt acg atg att Gln Met Met Gln Tyr Gly Gly Ala Lys Pro Gly Asp Arg Thr Met Ile 485 490 495	1488
gat gca atg tac cca gcc ttt atc gct tgg aaa aat gaa ggt ttt gaa Asp Ala Met Tyr Pro Ala Phe Ile Ala Trp Lys Asn Glu Gly Phe Glu 500 505 510	1536
gct gcc att gtt gcg gct aaa ata ggg gca gaa agc aca gcc act atg Ala Ala Ile Val Ala Ala Lys Ile Gly Ala Glu Ser Thr Ala Thr Met 515 520 525	1584
gtc gaa gcc aaa gca gga cgc tct tct tat tta aac agt gag agt tta Val Glu Ala Lys Ala Gly Arg Ser Ser Tyr Leu Asn Ser Glu Ser Leu 530 535 540	1632



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aaa ggt gtt aaa gat ccg ggc tca gtc gct gtt gag ttg gtt ttt gac 1680  
 Lys Gly Val Lys Asp Pro Gly Ser Val Ala Val Glu Leu Val Phe Asp  
 545 550 555 560

gcg ttt aat gtg taa 1695  
 Ala Phe Asn Val

<210> SEQ ID NO 53  
 <211> LENGTH: 564  
 <212> TYPE: PRT  
 <213> ORGANISM: Psychromonas sp. CNPT3

<400> SEQUENCE: 53

Met Val Ile Leu Phe Phe Asn Leu Leu Tyr Phe Lys Leu Leu Phe Gly  
 1 5 10 15

Val Ile Met Ser Arg Leu Phe Ile Asn Asp Lys Ala Thr Leu Val His  
 20 25 30

Asp Ala Ile Asp Gly Ile Leu Tyr Ser Asn Lys His Asn Asn Leu Val  
 35 40 45

Arg Leu Asp Val Asp Pro Gln Ile Arg Ile Val Thr Arg Asn Asp Trp  
 50 55 60

His His Asp Lys Val Ala Ile Ile Ser Gly Gly Gly Ser Gly His Glu  
 65 70 75 80

Pro Ala His Val Gly Phe Ile Gly Lys Gly Met Leu Thr Ala Ala Val  
 85 90 95

Cys Gly Asp Val Phe Ala Ser Pro Ser Val Asp Ala Val Leu Asn Ala  
 100 105 110

Ile Val His Val Thr Gly Glu Lys Gly Cys Leu Val Ile Val Lys Asn  
 115 120 125

Tyr Thr Gly Asp Arg Leu Asn Phe Gly Leu Ala Cys Glu Lys Ala Lys  
 130 135 140

Lys Met Gly Leu Asn Val Glu Met Val Ile Val Asp Asp Asp Ile Ser  
 145 150 155 160

Ile Pro Asp Asn Leu Lys Pro Arg Gly Ile Ala Gly Thr Leu Phe Val  
 165 170 175

His Lys Val Ala Gly Asn Ala Ala Glu Gln Gly Ala Ser Leu Asn Val  
 180 185 190

Val Lys Lys Ala Ala Gln Gly Ala Ile Asp Ala Thr Ala Ser Ile Gly  
 195 200 205

Leu Ala Leu Thr Ser Cys Ser Leu Pro Gly Glu Glu Ser Thr Gln Arg  
 210 215 220

Ile Ala Glu Gly Lys Ala Glu Leu Gly Leu Gly Ile His Gly Glu Pro  
 225 230 235 240

Gly Ile Lys Thr Ile Asp Val Thr Cys Cys Arg Asp Leu Val Met Ile  
 245 250 255

Met Val Asp Lys Leu Lys Gln Ser Phe Ser Ala Pro Asp Ile Lys Ile  
 260 265 270

Ala Val Met Ile Asn Asn Leu Gly Gly Val Ser Pro Leu Glu Met Ser  
 275 280 285

Leu Ile Cys Lys Asp Ile Val Glu Ser Glu Leu Lys Asn Asn Ile Glu  
 290 295 300

Leu Val Val Gly Pro Ala Pro Phe Met Thr Ala Ile Asp Met Lys Gly  
 305 310 315 320

Phe Ser Ile Ser Val Ile Glu Leu Thr Gly Asp His Ala Gln Ala Leu  
 325 330 335

Cys Ala Pro Val Glu Val Asp Ala Trp Val Glu Ala Ile Pro Leu Arg

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340				345				350							
Pro	Leu	Asn	Val	Ile	Lys	Lys	Asp	Lys	Val	Ser	Ile	Asn	Phe	Ala	Phe
	355						360					365			
Glu	Ala	Ser	Glu	Asn	Ala	Gln	Val	Ala	Ser	Ile	Val	Lys	Thr	Val	Thr
	370					375					380				
Leu	Ala	Leu	Ile	Asn	Ala	Glu	Lys	Glu	Leu	Asn	Arg	Leu	Asp	Thr	Leu
385				390						395					400
Val	Gly	Asp	Gly	Asp	Thr	Gly	Ser	Thr	Phe	Ser	Ala	Gly	Ala	Arg	Gln
				405					410					415	
Val	Leu	Ala	Glu	Leu	Asn	Ala	Gly	Asn	Leu	Pro	Leu	Asn	Asp	Thr	Gly
		420						425				430			
Ala	Leu	Leu	Asn	Val	Ile	Gly	Glu	Gln	Leu	Ala	Thr	Val	Met	Gly	Gly
		435					440					445			
Ser	Ser	Gly	Val	Leu	Phe	Ser	Ile	Phe	Phe	Thr	Ala	Ala	Gly	His	His
	450					455					460				
Tyr	Gln	Gln	His	Gly	Asp	Thr	Val	Gln	Ala	Leu	Gln	Ala	Gly	Leu	Gln
465					470					475					480
Gln	Met	Met	Gln	Tyr	Gly	Gly	Ala	Lys	Pro	Gly	Asp	Arg	Thr	Met	Ile
				485					490					495	
Asp	Ala	Met	Tyr	Pro	Ala	Phe	Ile	Ala	Trp	Lys	Asn	Glu	Gly	Phe	Glu
			500					505					510		
Ala	Ala	Ile	Val	Ala	Ala	Lys	Ile	Gly	Ala	Glu	Ser	Thr	Ala	Thr	Met
		515					520					525			
Val	Glu	Ala	Lys	Ala	Gly	Arg	Ser	Ser	Tyr	Leu	Asn	Ser	Glu	Ser	Leu
	530					535					540				
Lys	Gly	Val	Lys	Asp	Pro	Gly	Ser	Val	Ala	Val	Glu	Leu	Val	Phe	Asp
545				550					555						560
Ala	Phe	Asn	Val												

<210> SEQ ID NO 54  
 <211> LENGTH: 1647  
 <212> TYPE: DNA  
 <213> ORGANISM: *Staplia aggregata* IAM12614  
 <220> FEATURE:  
 <221> NAME/KEY: CDS1  
 <222> LOCATION: (1)..(1647)  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1647)

<400> SEQUENCE: 54

atg aag caa ttc atc aat acc aag gaa acg ctc gtc acc gaa gcg att	48
Met Lys Gln Phe Ile Asn Thr Lys Glu Thr Leu Val Thr Glu Ala Ile	
1 5 10 15	
gac ggc atg ttg cgc acg gcc gcc ggg cgg ctt gcc cgg ctt gac ggc	96
Asp Gly Met Leu Arg Thr Ala Gly Gly Arg Leu Ala Arg Leu Asp Gly	
20 25 30	
tat ccg cat atc aag gtg gtc gtg cgc acc gac tgg gac aaa tcg aag	144
Tyr Pro His Ile Lys Val Val Val Arg Thr Asp Trp Asp Lys Ser Lys	
35 40 45	
gtg gct ctg gtg tcc gcc gcc ggt tcc gcc cac gag ccg agc cat gcc	192
Val Ala Leu Val Ser Gly Gly Gly Ser Gly His Glu Pro Ser His Ala	
50 55 60	
ggt ttc gtc gcc cag gcc atg ctg acg gcg gcc gtc tgc gcc gaa gtg	240
Gly Phe Val Gly Gln Gly Met Leu Thr Ala Ala Val Cys Gly Glu Val	
65 70 75 80	
ttt gcc tcg cct tcc gtg gat gcg gtg ctg gcg gcc att ctg gcc gtc	288
Phe Ala Ser Pro Ser Val Asp Ala Val Leu Ala Gly Ile Leu Ala Val	
85 90 95	



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acc ggc aag gct ggc tgc ctg ctg atc gtc aag aac tac acc ggc gac	336
Thr Gly Lys Ala Gly Cys Leu Leu Ile Val Lys Asn Tyr Thr Gly Asp	
100 105 110	
cgg ctg aac ttc ggt ctg gcc gcc gag cgg gcc cgc tcc ttc gga ctg	384
Arg Leu Asn Phe Gly Leu Ala Ala Glu Arg Ala Arg Ser Phe Gly Leu	
115 120 125	
aag gtc aac atg gtg atc gtc gac gac gac gtt gcc ctg ccg gac ctg	432
Lys Val Asn Met Val Ile Val Asp Asp Asp Val Ala Leu Pro Asp Leu	
130 135 140	
ccg cag gcg cgc ggt gtc gcc gcc acg ctg ttc gtg cac aag atc gcc	480
Pro Gln Ala Arg Gly Val Ala Gly Thr Leu Phe Val His Lys Ile Ala	
145 150 155 160	
gga gcg ctt gcc gat cag ggt gcg gat ctg gaa acc atc acg gag gcc	528
Gly Ala Leu Ala Asp Gln Gly Ala Asp Leu Glu Thr Ile Thr Glu Ala	
165 170 175	
gcc agg aaa acc atc ggc ggt gcg att tcc atc ggc atg tcg ctg gac	576
Ala Arg Lys Thr Ile Gly Gly Ala Ile Ser Ile Gly Met Ser Leu Asp	
180 185 190	
acc tgc acg gtg ccg gga tcg ccc aag gaa gac cgc att gca cac ggc	624
Thr Cys Thr Val Pro Gly Ser Pro Lys Glu Asp Arg Ile Ala His Gly	
195 200 205	
aag gcg gaa ctc gga ctt ggc att cac ggc gag gcg ggg atc gag cag	672
Lys Ala Glu Leu Gly Leu Gly Ile His Gly Glu Ala Gly Ile Glu Gln	
210 215 220	
gtc gac tat tcc aac gcc cgc gcg gcc atg gcc atg gtg gtg gac cgg	720
Val Asp Tyr Ser Asn Ala Arg Ala Ala Met Ala Met Val Val Asp Arg	
225 230 235 240	
ctg gcg ccg aac ctc tcg ccc gga ccg cat gtg gcg atc ctc aac aat	768
Leu Ala Pro Asn Leu Ser Pro Gly Pro His Val Ala Ile Leu Asn Asn	
245 250 255	
ctg ggc agc acg acg ccg ctg gaa atg tcg gtg ctt ctg gaa gaa ctc	816
Leu Gly Ser Thr Thr Pro Leu Glu Met Ser Val Leu Leu Glu Glu Leu	
260 265 270	
acg gct tcg cgc atc ggc agc cag atc cgc tgg gtc atc ggc ccg gcg	864
Thr Ala Ser Arg Ile Gly Ser Gln Ile Arg Trp Val Ile Gly Pro Ala	
275 280 285	
gcg atg atg acc tcg ctc gac atg cat ggg ttc tcc gtg tcg ctg ctg	912
Ala Met Met Thr Ser Leu Asp Met His Gly Phe Ser Val Ser Leu Leu	
290 295 300	
ccg gtc ggc aag acc gaa gaa gcc ttg ctg cag gcc ccg gtc gcg ccc	960
Pro Val Gly Lys Thr Glu Glu Ala Leu Leu Gln Ala Pro Val Ala Pro	
305 310 315 320	
tgg gca tgg ccc ggc tgc ctt gcg ctt ggc gca gtg tcc gtg ctg ccg	1008
Trp Ala Trp Pro Gly Cys Leu Ala Leu Gly Ala Val Ser Val Leu Pro	
325 330 335	
cta ccg gac ggc ctg acg ccg atc cag ccg ctg ccg tcc aag aac ccg	1056
Leu Pro Asp Gly Leu Thr Pro Ile Gln Pro Leu Pro Ser Lys Asn Pro	
340 345 350	
gag acg ccg aag ttc atc gag cgc tgc tgc gat atc ctg atc gcc gcc	1104
Glu Thr Arg Lys Phe Ile Glu Arg Cys Cys Asp Ile Leu Ile Ala Ala	
355 360 365	
gag gac gac ctc aat gcg ctc gac gcc aag tcg ggc gac ggc gac acc	1152
Glu Asp Asp Leu Asn Ala Leu Asp Ala Lys Ser Gly Asp Gly Asp Thr	
370 375 380	
ggc agc acg ctt gcc acc gcc gcc ccg gcg ctg gtg aag gcg ctc gac	1200
Gly Ser Thr Leu Ala Thr Ala Ala Arg Ala Leu Val Lys Ala Leu Asp	
385 390 395 400	
cgg ctg ccg ctg gcg gat ctc acc cag ctc tac ccg gcc atc ggg ctg	1248
Arg Leu Pro Leu Ala Asp Leu Thr Gln Leu Tyr Arg Ala Ile Gly Leu	
405 410 415	

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gaa ctc agc cag acc atg ggc ggg tct tcc ggg gtg ctg ctg gcg atc 1296  
 Glu Leu Ser Gln Thr Met Gly Gly Ser Ser Gly Val Leu Leu Ala Ile  
                   420                                  425                                  430

ttc ttt gcc gct gcg ggc gat gcg tcg tcc agc ggg cgc ggg gcc atc 1344  
 Phe Phe Ala Ala Ala Gly Asp Ala Ser Ser Ser Gly Arg Gly Ala Ile  
                   435                                  440                                  445

gga gcc ctg aag gcc ggt ctt gac cgg atc atg cag gtg gcc ggc gcc 1392  
 Gly Ala Leu Lys Ala Gly Leu Asp Arg Ile Met Gln Val Gly Gly Ala  
                   450                                  455                                  460

cag ccg ggc gac cgc acc atg atc gac gcg ctg ctg ccg gca ctg aat 1440  
 Gln Pro Gly Asp Arg Thr Met Ile Asp Ala Leu Leu Pro Ala Leu Asn  
 465                                  470                                  475                                  480

gcg ctg gaa aac ggt atc gag gct gcg gcg agc gag gcc cgt cag ggg 1488  
 Ala Leu Glu Asn Gly Ile Glu Ala Ala Ala Ser Glu Ala Arg Gln Gly  
                                   485                                  490                                  495

gcg gat gcg acg tcg cgg atc acg cgg gca cgc gcg ggc agg gcg tct 1536  
 Ala Asp Ala Thr Ser Arg Ile Thr Arg Ala Arg Ala Gly Arg Ala Ser  
                                   500                                  505                                  510

tat gtc tcc gag gcc agc ctc tcc gga cac aac gat ccg ggc gcg gaa 1584  
 Tyr Val Ser Glu Ala Ser Leu Ser Gly His Asn Asp Pro Gly Ala Glu  
                   515                                  520                                  525

gcc gtt gcg cgg ctg ttc gag caa ttg acc ctt tct ccg gcc ctt acc 1632  
 Ala Val Ala Arg Leu Phe Glu Gln Leu Thr Leu Ser Pro Ala Leu Thr  
                   530                                  535                                  540

tcc aag tcc gca tag 1647  
 Ser Lys Ser Ala  
 545

<210> SEQ ID NO 55  
 <211> LENGTH: 548  
 <212> TYPE: PRT  
 <213> ORGANISM: *Stapia aggregata* IAM12614

<400> SEQUENCE: 55

Met Lys Gln Phe Ile Asn Thr Lys Glu Thr Leu Val Thr Glu Ala Ile  
 1                                  5                                  10                                  15

Asp Gly Met Leu Arg Thr Ala Gly Gly Arg Leu Ala Arg Leu Asp Gly  
                   20                                  25                                  30

Tyr Pro His Ile Lys Val Val Val Arg Thr Asp Trp Asp Lys Ser Lys  
                   35                                  40                                  45

Val Ala Leu Val Ser Gly Gly Gly Ser Gly His Glu Pro Ser His Ala  
                   50                                  55                                  60

Gly Phe Val Gly Gln Gly Met Leu Thr Ala Ala Val Cys Gly Glu Val  
 65                                  70                                  75                                  80

Phe Ala Ser Pro Ser Val Asp Ala Val Leu Ala Gly Ile Leu Ala Val  
                   85                                  90                                  95

Thr Gly Lys Ala Gly Cys Leu Leu Ile Val Lys Asn Tyr Thr Gly Asp  
                   100                                  105                                  110

Arg Leu Asn Phe Gly Leu Ala Ala Glu Arg Ala Arg Ser Phe Gly Leu  
                   115                                  120                                  125

Lys Val Asn Met Val Ile Val Asp Asp Asp Val Ala Leu Pro Asp Leu  
                   130                                  135                                  140

Pro Gln Ala Arg Gly Val Ala Gly Thr Leu Phe Val His Lys Ile Ala  
 145                                  150                                  155                                  160

Gly Ala Leu Ala Asp Gln Gly Ala Asp Leu Glu Thr Ile Thr Glu Ala  
                   165                                  170                                  175

Ala Arg Lys Thr Ile Gly Gly Ala Ile Ser Ile Gly Met Ser Leu Asp  
                   180                                  185                                  190



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Thr Cys Thr Val Pro Gly Ser Pro Lys Glu Asp Arg Ile Ala His Gly  
 195 200 205  
 Lys Ala Glu Leu Gly Leu Gly Ile His Gly Glu Ala Gly Ile Glu Gln  
 210 215 220  
 Val Asp Tyr Ser Asn Ala Arg Ala Ala Met Ala Met Val Val Asp Arg  
 225 230 235 240  
 Leu Ala Pro Asn Leu Ser Pro Gly Pro His Val Ala Ile Leu Asn Asn  
 245 250 255  
 Leu Gly Ser Thr Thr Pro Leu Glu Met Ser Val Leu Leu Glu Glu Leu  
 260 265 270  
 Thr Ala Ser Arg Ile Gly Ser Gln Ile Arg Trp Val Ile Gly Pro Ala  
 275 280 285  
 Ala Met Met Thr Ser Leu Asp Met His Gly Phe Ser Val Ser Leu Leu  
 290 295 300  
 Pro Val Gly Lys Thr Glu Glu Ala Leu Leu Gln Ala Pro Val Ala Pro  
 305 310 315 320  
 Trp Ala Trp Pro Gly Cys Leu Ala Leu Gly Ala Val Ser Val Leu Pro  
 325 330 335  
 Leu Pro Asp Gly Leu Thr Pro Ile Gln Pro Leu Pro Ser Lys Asn Pro  
 340 345 350  
 Glu Thr Arg Lys Phe Ile Glu Arg Cys Cys Asp Ile Leu Ile Ala Ala  
 355 360 365  
 Glu Asp Asp Leu Asn Ala Leu Asp Ala Lys Ser Gly Asp Gly Asp Thr  
 370 375 380  
 Gly Ser Thr Leu Ala Thr Ala Ala Arg Ala Leu Val Lys Ala Leu Asp  
 385 390 395 400  
 Arg Leu Pro Leu Ala Asp Leu Thr Gln Leu Tyr Arg Ala Ile Gly Leu  
 405 410 415  
 Glu Leu Ser Gln Thr Met Gly Gly Ser Ser Gly Val Leu Leu Ala Ile  
 420 425 430  
 Phe Phe Ala Ala Ala Gly Asp Ala Ser Ser Ser Gly Arg Gly Ala Ile  
 435 440 445  
 Gly Ala Leu Lys Ala Gly Leu Asp Arg Ile Met Gln Val Gly Gly Ala  
 450 455 460  
 Gln Pro Gly Asp Arg Thr Met Ile Asp Ala Leu Leu Pro Ala Leu Asn  
 465 470 475 480  
 Ala Leu Glu Asn Gly Ile Glu Ala Ala Ala Ser Glu Ala Arg Gln Gly  
 485 490 495  
 Ala Asp Ala Thr Ser Arg Ile Thr Arg Ala Arg Ala Gly Arg Ala Ser  
 500 505 510  
 Tyr Val Ser Glu Ala Ser Leu Ser Gly His Asn Asp Pro Gly Ala Glu  
 515 520 525  
 Ala Val Ala Arg Leu Phe Glu Gln Leu Thr Leu Ser Pro Ala Leu Thr  
 530 535 540  
 Ser Lys Ser Ala  
 545

<210> SEQ ID NO 56  
 <211> LENGTH: 1641  
 <212> TYPE: DNA  
 <213> ORGANISM: Rhizobium leguminosarum  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1641)

<400> SEQUENCE: 56

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atg aaa cac ttc ttc aac cgc agg gaa aac atc gtc acc gaa gcc ttg	48
Met Lys His Phe Phe Asn Arg Arg Glu Asn Ile Val Thr Glu Ala Leu	
1 5 10 15	
gac ggt ctg ctt ctg acg agc agc aag ggt cgt ctt gcc cgc ctc gac	96
Asp Gly Leu Leu Leu Thr Ser Ser Lys Gly Arg Leu Ala Arg Leu Asp	
20 25 30	
agc ttt ccc gac atc aag gtg atc ctg cgc gct gac tgg gac aag tcg	144
Ser Phe Pro Asp Ile Lys Val Ile Leu Arg Ala Asp Trp Asp Lys Ser	
35 40 45	
aag gtg gcg atc atc tca ggc ggc ggc gcc ggt cat gag ccc tcc cat	192
Lys Val Ala Ile Ile Ser Gly Gly Gly Ala Gly His Glu Pro Ser His	
50 55 60	
gcc ggc ttc gtc ggt aag ggc atg ctg acg gct gcc gta tcc ggc gag	240
Ala Gly Phe Val Gly Lys Gly Met Leu Thr Ala Ala Val Ser Gly Glu	
65 70 75 80	
att ttc gcc tcg ccg agc gtc gat gcc gtg ctg aca gcg atc cgc gcc	288
Ile Phe Ala Ser Pro Ser Val Asp Ala Val Leu Thr Ala Ile Arg Ala	
85 90 95	
gtc gcc ggc gaa aag ggc gcc ttg ctg atc gtc aag aac tat acc ggc	336
Val Ala Gly Glu Lys Gly Ala Leu Leu Ile Val Lys Asn Tyr Thr Gly	
100 105 110	
gac cgg ctg aat ttc ggc ctc gcc gcc gag aag gcg cgc gcc gaa ggt	384
Asp Arg Leu Asn Phe Gly Leu Ala Ala Glu Lys Ala Arg Ala Glu Gly	
115 120 125	
ttc gac gtc gaa atg gtc atc gtc gcc gac gat atc gcc atc ccc gag	432
Phe Asp Val Glu Met Val Ile Val Ala Asp Asp Ile Ala Ile Pro Glu	
130 135 140	
atc aac cag ccg cgc ggc gtc gcc ggg act ctg ttc gtc cac aag atc	480
Ile Asn Gln Pro Arg Gly Val Ala Gly Thr Leu Phe Val His Lys Ile	
145 150 155 160	
gct ggc tat cac gcc gaa agg ggc gag gac ctg aag acg gtc gca gcc	528
Ala Gly Tyr His Ala Glu Arg Gly Glu Asp Leu Lys Thr Val Ala Ala	
165 170 175	
cat gcc gcg gca gcg gcc ggc gac atc gtc tcg ctc ggc atg tct ctg	576
His Ala Ala Ala Ala Ala Gly Asp Ile Val Ser Leu Gly Met Ser Leu	
180 185 190	
tcc acc tgc agc gtg ccc ggc cag gcg cat gag agc cgc ctc ggc gag	624
Ser Thr Cys Ser Val Pro Gly Gln Ala His Glu Ser Arg Leu Gly Glu	
195 200 205	
aac gag ggc gaa ctc ggt ctc ggc atc cat ggc gag ccc ggc gtc gag	672
Asn Glu Gly Glu Leu Gly Leu Gly Ile His Gly Glu Pro Gly Val Glu	
210 215 220	
cgc att gcg ctg cag ccg gtc gtc gat atc gtc gcc acc atg gtg gcg	720
Arg Ile Ala Leu Gln Pro Val Val Asp Ile Val Ala Thr Met Val Ala	
225 230 235 240	
cgc cta tcg cct gcg ctg cgc gaa ggg gga aac cac gcc ctt ctc atc	768
Arg Leu Ser Pro Ala Leu Arg Glu Gly Gly Asn His Ala Leu Leu Ile	
245 250 255	
aac aat ctc ggc gcc gta ccg ccg ctc gaa atg acc gtt att gcc aat	816
Asn Asn Leu Gly Ala Val Pro Pro Leu Glu Met Thr Val Ile Ala Asn	
260 265 270	
gtg gtg ctg tcc tcg tcg ctt gcc gat cgc gtc agg ctg atc atc ggc	864
Val Val Leu Ser Ser Ser Leu Ala Asp Arg Val Arg Leu Ile Ile Gly	
275 280 285	
ccg gcg ccg atg atg acc gcg ctc aac atg aac ggc ttc tcg ctg tcg	912
Pro Ala Pro Met Met Thr Ala Leu Asn Met Asn Gly Phe Ser Leu Ser	
290 295 300	
ctg atc cga ctg gat gcc gct cgc gag gcg gcg ctg acg gca gcg gtc	960
Leu Ile Arg Leu Asp Ala Ala Arg Glu Ala Ala Leu Thr Ala Ala Val	
305 310 315 320	



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gaa ccg cat gcc tgg atg cca gcc gtc gaa cgc cac gag atc agg gtc Glu Pro His Ala Trp Met Pro Ala Val Glu Arg His Glu Ile Arg Val 325 330 335	1008
atc gcc gca ccg cga aca tca gcc gga ctg aac ggc gcg cca gtg gcc Ile Ala Ala Pro Arg Thr Ser Ala Gly Leu Asn Gly Ala Pro Val Ala 340 345 350	1056
ggg gat aat ctc cgc aac cgg cgt ctg atc aca gcg ctc tgc gag cat Gly Asp Asn Leu Arg Asn Arg Arg Leu Ile Thr Ala Leu Cys Glu His 355 360 365	1104
ctg atc tcg cag gaa agc gaa ctc aac cgg ctg gat ggc cgc gtc ggc Leu Ile Ser Gln Glu Ser Glu Leu Asn Arg Leu Asp Gly Arg Val Gly 370 375 380	1152
gac ggt gat acc ggc tcg acg gtg gcg aca ggc gcc cgc agc gtg ctt Asp Gly Asp Thr Gly Ser Thr Val Ala Thr Gly Ala Arg Ser Val Leu 385 390 395 400	1200
gcc cgc ctg gac acg ctg ccg ctt gat cgg ccg gct gca acg ctt gcc Ala Arg Leu Asp Thr Leu Pro Leu Asp Arg Pro Ala Ala Thr Leu Ala 405 410 415	1248
tcg ctc ggc gac atc ctc ggc acc agc atg ggc gga tcg agc ggc gtg Ser Leu Gly Asp Ile Leu Gly Thr Ser Met Gly Gly Ser Ser Gly Val 420 425 430	1296
ctg ctg tcg atc ttc ttc acc gca gcg gca aag gcg atg gcc gac aag Leu Leu Ser Ile Phe Phe Thr Ala Ala Ala Lys Ala Met Ala Asp Lys 435 440 445	1344
gcc gat ata tca gca gcc ctt att gcc ggg ctc gac agg atg acg ttc Ala Asp Ile Ser Ala Ala Leu Ile Ala Gly Leu Asp Arg Met Thr Phe 450 455 460	1392
tat ggc gga gcc gaa gtc ggc gac cgg acg atg gtc gat gcg ctg tcg Tyr Gly Gly Ala Glu Val Gly Asp Arg Thr Met Val Asp Ala Leu Ser 465 470 475 480	1440
cct gcc ctg cag gcg ctc gca tcc ggc gat gtc gcg gca gcg gcc agg Pro Ala Leu Gln Ala Leu Ala Ser Gly Asp Val Ala Ala Ala Ala Arg 485 490 495	1488
gct gct gcc gca ggt gcg gag tcg acg aag acg atg atg aaa gcg aga Ala Ala Ala Ala Gly Ala Glu Ser Thr Lys Thr Met Met Lys Ala Arg 500 505 510	1536
gcc ggc cgc gcc tcc tat gtc ggc gaa agg gat ctg gca ggt gtc gct Ala Gly Arg Ala Ser Tyr Val Gly Glu Arg Asp Leu Ala Gly Val Ala 515 520 525	1584
gat ccc ggc gcc gtc gcg gtt gcc ggc gcg ttc ggt gtg gcg gca agc Asp Pro Gly Ala Val Ala Val Ala Gly Ala Phe Gly Val Ala Ala Ser 530 535 540	1632
ctc gcc tga Leu Ala 545	1641

<210> SEQ ID NO 57  
 <211> LENGTH: 546  
 <212> TYPE: PRT  
 <213> ORGANISM: Rhizobium leguminosarum

<400> SEQUENCE: 57

Met Lys His Phe Phe Asn Arg Arg Glu Asn Ile Val Thr Glu Ala Leu 1 5 10 15
Asp Gly Leu Leu Leu Thr Ser Ser Lys Gly Arg Leu Ala Arg Leu Asp 20 25 30
Ser Phe Pro Asp Ile Lys Val Ile Leu Arg Ala Asp Trp Asp Lys Ser 35 40 45
Lys Val Ala Ile Ile Ser Gly Gly Gly Ala Gly His Glu Pro Ser His 50 55 60

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Ala Gly Phe Val Gly Lys Gly Met Leu Thr Ala Ala Val Ser Gly Glu  
65 70 75 80

Ile Phe Ala Ser Pro Ser Val Asp Ala Val Leu Thr Ala Ile Arg Ala  
85 90 95

Val Ala Gly Glu Lys Gly Ala Leu Leu Ile Val Lys Asn Tyr Thr Gly  
100 105 110

Asp Arg Leu Asn Phe Gly Leu Ala Ala Glu Lys Ala Arg Ala Glu Gly  
115 120 125

Phe Asp Val Glu Met Val Ile Val Ala Asp Asp Ile Ala Ile Pro Glu  
130 135 140

Ile Asn Gln Pro Arg Gly Val Ala Gly Thr Leu Phe Val His Lys Ile  
145 150 155 160

Ala Gly Tyr His Ala Glu Arg Gly Glu Asp Leu Lys Thr Val Ala Ala  
165 170 175

His Ala Ala Ala Ala Ala Gly Asp Ile Val Ser Leu Gly Met Ser Leu  
180 185 190

Ser Thr Cys Ser Val Pro Gly Gln Ala His Glu Ser Arg Leu Gly Glu  
195 200 205

Asn Glu Gly Glu Leu Gly Leu Gly Ile His Gly Glu Pro Gly Val Glu  
210 215 220

Arg Ile Ala Leu Gln Pro Val Val Asp Ile Val Ala Thr Met Val Ala  
225 230 235 240

Arg Leu Ser Pro Ala Leu Arg Glu Gly Gly Asn His Ala Leu Leu Ile  
245 250 255

Asn Asn Leu Gly Ala Val Pro Pro Leu Glu Met Thr Val Ile Ala Asn  
260 265 270

Val Val Leu Ser Ser Ser Leu Ala Asp Arg Val Arg Leu Ile Ile Gly  
275 280 285

Pro Ala Pro Met Met Thr Ala Leu Asn Met Asn Gly Phe Ser Leu Ser  
290 295 300

Leu Ile Arg Leu Asp Ala Ala Arg Glu Ala Ala Leu Thr Ala Ala Val  
305 310 315 320

Glu Pro His Ala Trp Met Pro Ala Val Glu Arg His Glu Ile Arg Val  
325 330 335

Ile Ala Ala Pro Arg Thr Ser Ala Gly Leu Asn Gly Ala Pro Val Ala  
340 345 350

Gly Asp Asn Leu Arg Asn Arg Arg Leu Ile Thr Ala Leu Cys Glu His  
355 360 365

Leu Ile Ser Gln Glu Ser Glu Leu Asn Arg Leu Asp Gly Arg Val Gly  
370 375 380

Asp Gly Asp Thr Gly Ser Thr Val Ala Thr Gly Ala Arg Ser Val Leu  
385 390 395 400

Ala Arg Leu Asp Thr Leu Pro Leu Asp Arg Pro Ala Ala Thr Leu Ala  
405 410 415

Ser Leu Gly Asp Ile Leu Gly Thr Ser Met Gly Gly Ser Ser Gly Val  
420 425 430

Leu Leu Ser Ile Phe Phe Thr Ala Ala Lys Ala Met Ala Asp Lys  
435 440 445

Ala Asp Ile Ser Ala Ala Leu Ile Ala Gly Leu Asp Arg Met Thr Phe  
450 455 460

Tyr Gly Gly Ala Glu Val Gly Asp Arg Thr Met Val Asp Ala Leu Ser  
465 470 475 480

Pro Ala Leu Gln Ala Leu Ala Ser Gly Asp Val Ala Ala Ala Arg



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485				490				495								
Ala	Ala	Ala	Ala	Gly	Ala	Glu	Ser	Thr	Lys	Thr	Met	Met	Lys	Ala	Arg	
			500						505				510			
Ala	Gly	Arg	Ala	Ser	Tyr	Val	Gly	Glu	Arg	Asp	Leu	Ala	Gly	Val	Ala	
			515				520						525			
Asp	Pro	Gly	Ala	Val	Ala	Val	Ala	Gly	Ala	Phe	Gly	Val	Ala	Ala	Ser	
			530				535				540					
Leu	Ala															
			545													
<210> SEQ ID NO 58																
<211> LENGTH: 1701																
<212> TYPE: DNA																
<213> ORGANISM: Myxococcus xanthus																
<220> FEATURE:																
<221> NAME/KEY: CDS																
<222> LOCATION: (1)..(1701)																
<400> SEQUENCE: 58																
atg	aag	aag	ctg	gtc	aac	gcc	cct	cgc	gcg	gtg	gtg	cgg	gag	atg	ctg	48
Met	Lys	Lys	Leu	Val	Asn	Ala	Pro	Arg	Ala	Val	Val	Arg	Glu	Met	Leu	
1				5				10				15				
gag	ggg	ttg	gtc	tcg	ctc	gcc	ccc	ggg	cag	gtg	ctg	ctg	gac	ggg	gag	96
Glu	Gly	Leu	Val	Ser	Leu	Ala	Pro	Gly	Gln	Val	Leu	Leu	Asp	Gly	Glu	
			20						25				30			
tcg	gtg	gtg	ctc	cgc	gcc	gac	acg	cct	tcc	gac	gtc	cgc	gcg	cgc	aag	144
Ser	Val	Val	Leu	Arg	Ala	Asp	Thr	Pro	Ser	Asp	Val	Arg	Ala	Arg	Lys	
			35				40				45					
gtg	gct	gtc	atc	tcc	ggt	ggc	ggc	agc	ggc	cat	gag	ccg	gcg	cac	gcg	192
Val	Ala	Val	Ile	Ser	Gly	Gly	Gly	Ser	Gly	His	Glu	Pro	Ala	His	Ala	
			50				55				60					
ggc	tac	gtg	ggc	gcg	ggc	atg	ctg	gac	gcg	gcg	gtg	gcc	ggt	gac	gtc	240
Gly	Tyr	Val	Gly	Ala	Gly	Met	Leu	Asp	Ala	Ala	Val	Ala	Gly	Asp	Val	
			65			70				75				80		
ttc	acc	tcg	ccc	agc	acc	gat	gcc	gtg	ctg	gcc	gcc	atc	cgc	gcc	gtc	288
Phe	Thr	Ser	Pro	Ser	Thr	Asp	Ala	Val	Leu	Ala	Ala	Ile	Arg	Ala	Val	
					85				90					95		
gcg	ggg	ccc	gcg	ggc	gcg	ctg	ctc	gtc	gtg	aag	aac	tac	acc	ggg	gac	336
Ala	Gly	Pro	Ala	Gly	Ala	Leu	Leu	Val	Val	Lys	Asn	Tyr	Thr	Gly	Asp	
			100						105				110			
cgg	ctc	aac	ttc	ggg	ctc	gcc	gcc	gag	ctg	gcg	cgc	gcc	gag	ggc	atc	384
Arg	Leu	Asn	Phe	Gly	Leu	Ala	Ala	Glu	Leu	Ala	Arg	Ala	Glu	Gly	Ile	
			115				120						125			
ccc	gtg	gag	acg	gtg	gtg	gtg	gcg	gac	gac	gtg	tcc	ctg	cac	gac	acg	432
Pro	Val	Glu	Thr	Val	Val	Val	Ala	Asp	Asp	Val	Ser	Leu	His	Asp	Thr	
			130				135				140					
gtg	gag	ccc	gcg	cgg	cgc	cgg	ggc	atc	gct	ggc	acg	gtg	ctg	gtc	cac	480
Val	Glu	Pro	Ala	Arg	Arg	Arg	Gly	Ile	Ala	Gly	Thr	Val	Leu	Val	His	
			145			150				155				160		
aag	gtc	gcg	ggc	gcg	gcg	gcc	gag	gcg	ggc	gcg	gcg	ctc	cag	gac	gtc	528
Lys	Val	Ala	Gly	Ala	Ala	Ala	Glu	Ala	Gly	Ala	Ala	Leu	Gln	Asp	Val	
			165						170				175			
ctc	cgc	gag	gcc	acc	gcg	gcg	gcg	gag	gtg	ctg	ggc	acc	atg	ggc	gtg	576
Leu	Arg	Glu	Ala	Thr	Ala	Ala	Ala	Glu	Val	Leu	Gly	Thr	Met	Gly	Val	
			180						185				190			
gcc	ctg	ggg	ccc	tgc	acc	gtg	ccc	gcg	gcg	ggc	aag	ccg	ggc	ttc	acg	624
Ala	Leu	Gly	Pro	Cys	Thr	Val	Pro	Ala	Ala	Gly	Lys	Pro	Gly	Phe	Thr	
			195				200				205					
ctg	gag	gag	gac	gaa	atc	gag	ctg	ggc	ctg	ggc	atc	cac	ggc	gag	cag	672
Leu	Glu	Glu	Asp	Glu	Ile	Glu	Leu	Gly	Leu	Gly	Ile	His	Gly	Glu	Gln	
			210				215				220					

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ggc gtg cgg cgc gtg ccg atg cag acg gcg gac agc ctg gtg gac acg Gly Val Arg Arg Val Pro Met Gln Thr Ala Asp Ser Leu Val Asp Thr 225 230 235 240	720
ctg ctc acc acc atc gtc gag gac cgg cgc atc acc tcg gga gac agg Leu Leu Thr Thr Ile Val Glu Asp Arg Arg Ile Thr Ser Gly Asp Arg 245 250 255	768
gtg gtg ctg gtg gtc aac gga ttg ggc ggc acg ccg ccc atg gag ctg Val Val Leu Val Val Asn Gly Leu Gly Gly Thr Pro Pro Met Glu Leu 260 265 270	816
gcc atc gtc gcc cgg cgc gca ctg gcc gct ctg cgt cag gcc gcc atc Ala Ile Val Ala Arg Arg Ala Leu Ala Ala Leu Arg Gln Gly Gly Ile 275 280 285	864
cgc gtg gag cgc gcg tgg agc ggg acg ttc ctc tcc gcg ctg gag atg Arg Val Glu Arg Ala Trp Ser Gly Thr Phe Leu Ser Ala Leu Glu Met 290 295 300	912
ccc gcc tgc tcg ttg acg ctg ctg aag gtg gac gac gcg cgg ctg gcc Pro Gly Cys Ser Leu Thr Leu Leu Lys Val Asp Asp Ala Arg Leu Ala 305 310 315 320	960
cgc ctg gat gcg gcg gtg gat gcg ccc gcg tgg ccc gcc gcg gga cgg Arg Leu Asp Ala Ala Val Asp Ala Pro Ala Trp Pro Gly Ala Gly Arg 325 330 335	1008
ctg ccg aag gag ccg ggg gtg tac cgg cct tcg tcc acg gcg tct cca Leu Pro Lys Glu Pro Gly Val Tyr Arg Pro Ser Ser Thr Ala Ser Pro 340 345 350	1056
gca tcg ctt ccg gcg gag gcg ccg caa ccg ggg atg gac cgc ttc cgg Ala Ser Leu Pro Ala Glu Ala Pro Gln Pro Gly Met Asp Arg Phe Arg 355 360 365	1104
aag gcc gcc ttg cgg gtg gcg gac gca ttc gag cag tcg gag ccc cgg Lys Ala Ala Leu Arg Val Ala Asp Ala Phe Glu Gln Ser Glu Pro Arg 370 375 380	1152
ctg acc gcg ctc gat agc gcc gcg ggc gac ggt gac ctg gcc ctc agt Leu Thr Ala Leu Asp Ser Ala Ala Gly Asp Gly Asp Leu Gly Leu Ser 385 390 395 400	1200
ctg gtg cgt gcc gcc gag gcg att cgc gct ctt ccg gag gac gcg tgg Leu Val Arg Gly Ala Glu Ala Ile Arg Ala Leu Pro Glu Asp Ala Trp 405 410 415	1248
acg agc ccc gcg cgt gcg ctg acg gcc att ggc aat gcc ttg cgg cgc Thr Ser Pro Ala Arg Ala Leu Thr Ala Ile Gly Asn Ala Leu Arg Arg 420 425 430	1296
agc att ggc gcc agc tcg ggg ccc ttc tac gcg acg gcg ctg ctg cgc Ser Ile Gly Gly Ser Ser Gly Pro Phe Tyr Ala Thr Ala Leu Leu Arg 435 440 445	1344
gcc gcg cgc agg ctg gcg gaa ggg ccc gtg gat gcc gcc gca tgg gcc Ala Ala Arg Arg Leu Ala Glu Gly Pro Val Asp Ala Ala Ala Trp Ala 450 455 460	1392
gag gcc ttc gac ctc gcc gtc acc gcc gta tcg gag ctg gcc gcc gcg Glu Ala Phe Asp Leu Ala Val Thr Ala Val Ser Glu Leu Gly Gly Ala 465 470 475 480	1440
cgg cct ggg gac cgc acc atg ctc gat gca ctc cgg ccc gcc gcc gac Arg Pro Gly Asp Arg Thr Met Leu Asp Ala Leu Arg Pro Ala Ala Asp 485 490 495	1488
gcc ttc gcg aag gcg gtg cgt tgc ggg cag ggg gct cgc gag gcc tgg Ala Phe Ala Lys Ala Val Arg Cys Gly Gln Gly Ala Arg Glu Ala Trp 500 505 510	1536
gcc tcg gcg gtg cac gcg gcc gag gcg gga gag gag gcg acg tcc cgg Ala Ser Ala Val His Ala Ala Glu Ala Gly Glu Glu Ala Thr Ser Arg 515 520 525	1584
atg cag ccg cgc ctg gga cgc gcc agc tac ctg ggt gcg cgc gcc gtc Met Gln Pro Arg Leu Gly Arg Ala Ser Tyr Leu Gly Ala Arg Ala Val 530 535 540	1632



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ggt gtg ccg gac gcg ggc gcc gcg gcc gtg gtg gtg tgg atg aag gcg 1680  
 Gly Val Pro Asp Ala Gly Ala Ala Ala Val Val Val Trp Met Lys Ala  
 545 550 555 560

ctc acg cct ggc atc ggc tga 1701  
 Leu Thr Pro Gly Ile Gly  
 565

<210> SEQ ID NO 59

<211> LENGTH: 566

<212> TYPE: PRT

<213> ORGANISM: Myxococcus xanthus

<400> SEQUENCE: 59

Met Lys Lys Leu Val Asn Ala Pro Arg Ala Val Val Arg Glu Met Leu  
 1 5 10 15

Glu Gly Leu Val Ser Leu Ala Pro Gly Gln Val Leu Leu Asp Gly Glu  
 20 25 30

Ser Val Val Leu Arg Ala Asp Thr Pro Ser Asp Val Arg Ala Arg Lys  
 35 40 45

Val Ala Val Ile Ser Gly Gly Gly Ser Gly His Glu Pro Ala His Ala  
 50 55 60

Gly Tyr Val Gly Ala Gly Met Leu Asp Ala Ala Val Ala Gly Asp Val  
 65 70 75 80

Phe Thr Ser Pro Ser Thr Asp Ala Val Leu Ala Ala Ile Arg Ala Val  
 85 90 95

Ala Gly Pro Ala Gly Ala Leu Leu Val Val Lys Asn Tyr Thr Gly Asp  
 100 105 110

Arg Leu Asn Phe Gly Leu Ala Ala Glu Leu Ala Arg Ala Glu Gly Ile  
 115 120 125

Pro Val Glu Thr Val Val Val Ala Asp Asp Val Ser Leu His Asp Thr  
 130 135 140

Val Glu Pro Ala Arg Arg Arg Gly Ile Ala Gly Thr Val Leu Val His  
 145 150 155 160

Lys Val Ala Gly Ala Ala Ala Glu Ala Gly Ala Ala Leu Gln Asp Val  
 165 170 175

Leu Arg Glu Ala Thr Ala Ala Ala Glu Val Leu Gly Thr Met Gly Val  
 180 185 190

Ala Leu Gly Pro Cys Thr Val Pro Ala Ala Gly Lys Pro Gly Phe Thr  
 195 200 205

Leu Glu Glu Asp Glu Ile Glu Leu Gly Leu Gly Ile His Gly Glu Gln  
 210 215 220

Gly Val Arg Arg Val Pro Met Gln Thr Ala Asp Ser Leu Val Asp Thr  
 225 230 235 240

Leu Leu Thr Thr Ile Val Glu Asp Arg Arg Ile Thr Ser Gly Asp Arg  
 245 250 255

Val Val Leu Val Val Asn Gly Leu Gly Gly Thr Pro Pro Met Glu Leu  
 260 265 270

Ala Ile Val Ala Arg Arg Ala Leu Ala Ala Leu Arg Gln Gly Gly Ile  
 275 280 285

Arg Val Glu Arg Ala Trp Ser Gly Thr Phe Leu Ser Ala Leu Glu Met  
 290 295 300

Pro Gly Cys Ser Leu Thr Leu Leu Lys Val Asp Asp Ala Arg Leu Ala  
 305 310 315 320

Arg Leu Asp Ala Ala Val Asp Ala Pro Ala Trp Pro Gly Ala Gly Arg  
 325 330 335

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Leu Pro Lys Glu Pro Gly Val Tyr Arg Pro Ser Ser Thr Ala Ser Pro  
 340 345 350

Ala Ser Leu Pro Ala Glu Ala Pro Gln Pro Gly Met Asp Arg Phe Arg  
 355 360 365

Lys Ala Ala Leu Arg Val Ala Asp Ala Phe Glu Gln Ser Glu Pro Arg  
 370 375 380

Leu Thr Ala Leu Asp Ser Ala Ala Gly Asp Gly Asp Leu Gly Leu Ser  
 385 390 395 400

Leu Val Arg Gly Ala Glu Ala Ile Arg Ala Leu Pro Glu Asp Ala Trp  
 405 410 415

Thr Ser Pro Ala Arg Ala Leu Thr Ala Ile Gly Asn Ala Leu Arg Arg  
 420 425 430

Ser Ile Gly Gly Ser Ser Gly Pro Phe Tyr Ala Thr Ala Leu Leu Arg  
 435 440 445

Ala Ala Arg Arg Leu Ala Glu Gly Pro Val Asp Ala Ala Ala Trp Ala  
 450 455 460

Glu Ala Phe Asp Leu Ala Val Thr Ala Val Ser Glu Leu Gly Gly Ala  
 465 470 475 480

Arg Pro Gly Asp Arg Thr Met Leu Asp Ala Leu Arg Pro Ala Ala Asp  
 485 490 495

Ala Phe Ala Lys Ala Val Arg Cys Gly Gln Gly Ala Arg Glu Ala Trp  
 500 505 510

Ala Ser Ala Val His Ala Ala Glu Ala Gly Glu Glu Ala Thr Ser Arg  
 515 520 525

Met Gln Pro Arg Leu Gly Arg Ala Ser Tyr Leu Gly Ala Arg Ala Val  
 530 535 540

Gly Val Pro Asp Ala Gly Ala Ala Ala Val Val Val Trp Met Lys Ala  
 545 550 555 560

Leu Thr Pro Gly Ile Gly  
 565

<210> SEQ ID NO 60  
 <211> LENGTH: 1701  
 <212> TYPE: DNA  
 <213> ORGANISM: Burkholderia sp. 383  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1701)

<400> SEQUENCE: 60

atg aaa aag ctt gtc aac cgc ccg tcc gat gtc gtg cga gaa atg ctg	48
Met Lys Lys Leu Val Asn Arg Pro Ser Asp Val Val Arg Glu Met Leu	
1 5 10 15	
gaa ggc atc gcg cgg cag tcg ccg cat gtc gcg atc ctc ggc gac gag	96
Glu Gly Ile Ala Arg Gln Ser Pro His Val Ala Ile Leu Gly Asp Glu	
20 25 30	
cac gtg ctc gtc cgc cag ccg ctg ccc gag ccc gcg caa cgc ccc gtc	144
His Val Leu Val Arg Gln Pro Leu Pro Glu Pro Ala Gln Arg Pro Val	
35 40 45	
gcc atc ctg tcc ggt ggc ggc agc ggc cac gag ccc gcg cac ggc ggc	192
Ala Ile Leu Ser Gly Gly Ser Gly His Glu Pro Ala His Gly Gly	
50 55 60	
tat gtc ggc gaa gga atg ctg agc gcg gcc gtc tgc ggc gaa gtg ttc	240
Tyr Val Gly Glu Gly Met Leu Ser Ala Ala Val Cys Gly Glu Val Phe	
65 70 75 80	
acg tcg ccg tcc aca gac gcc gtg ctc gcc gcg atc cgc gcg agc gcc	288
Thr Ser Pro Ser Thr Asp Ala Val Leu Ala Ala Ile Arg Ala Ser Ala	
85 90 95	



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ggc ccg aac ggc gcc ttg ctg atc gtg aag aac tac acg ggc gac cgg	336
Gly Pro Asn Gly Ala Leu Leu Ile Val Lys Asn Tyr Thr Gly Asp Arg	
100 105 110	
ctc aat ttc ggg ctc gcc gcc gaa ctc gca cgc gcc gaa ggc att ccg	384
Leu Asn Phe Gly Leu Ala Ala Glu Leu Ala Arg Ala Glu Gly Ile Pro	
115 120 125	
gtc gag acg gtc atc gtc gcc gac gac gta tcg ctg cgc ggc cgc gtc	432
Val Glu Thr Val Ile Val Ala Asp Asp Val Ser Leu Arg Gly Arg Val	
130 135 140	
gag cgc ggc cag cgg cgc ggg atc gcc ggt acc gtg ctg atc cac aag	480
Glu Arg Gly Gln Arg Arg Gly Ile Ala Gly Thr Val Leu Ile His Lys	
145 150 155 160	
ctc gcc ggc gcg gca gcc gcg cgc ggg ctg ccg ctc gcc cgc gtc gcg	528
Leu Ala Gly Ala Ala Ala Arg Gly Leu Pro Leu Ala Arg Val Ala	
165 170 175	
gcc atc gcg cgc gac gcg gcg gcc gaa ctc ggc acg atg ggt gtc gca	576
Ala Ile Ala Arg Asp Ala Ala Ala Glu Leu Gly Thr Met Gly Val Ala	
180 185 190	
ctc gac ggc tgc acg atc ccg ggc gcc gac aag tcg ggc ttc agc ctc	624
Leu Asp Gly Cys Thr Ile Pro Gly Ala Asp Lys Ser Gly Phe Ser Leu	
195 200 205	
ggc gat cac gag atc gaa ctc ggc ctc ggc atc cat ggc gag aaa ggc	672
Gly Asp His Glu Ile Glu Leu Gly Leu Gly Ile His Gly Glu Lys Gly	
210 215 220	
gtc gag cgc cgc gcg ccg ctg ccg gcc gat gcg ctt gtc gac acg ctg	720
Val Glu Arg Arg Ala Pro Leu Pro Ala Asp Ala Leu Val Asp Thr Leu	
225 230 235 240	
ctg tcg agc atc gcc gcc gat ctc gtg ctc gac cgc ggc gaa cgc gtt	768
Leu Ser Ser Ile Ala Ala Asp Leu Val Leu Asp Arg Gly Glu Arg Val	
245 250 255	
gcg ctg ttc gtc aac ggc ctc ggc gcg acg ccg gac atg gaa ctc gcg	816
Ala Leu Phe Val Asn Gly Leu Gly Ala Thr Pro Asp Met Glu Leu Ala	
260 265 270	
atc gtg ctg cgc gcc gcg cac gac aac ctg cac cgg cgc ggc atc gtc	864
Ile Val Leu Arg Ala Ala His Asp Asn Leu His Arg Arg Gly Ile Val	
275 280 285	
gtc gcg cgt gcg tgg gcc ggc acg ttc ctg tcg gcg ctg aac atg ccc	912
Val Ala Arg Ala Trp Ala Gly Thr Phe Leu Ser Ala Leu Asn Met Pro	
290 295 300	
ggc tgc tcg atc tcg gtg ctg cgg ctg aac gac gaa cgc gcg gtg ctg	960
Gly Cys Ser Ile Ser Val Leu Arg Leu Asn Asp Glu Arg Ala Val Leu	
305 310 315 320	
ctc gac gca ccg acg cag gcg cgt gca tgg cca ggc ggc ggc gcg gtg	1008
Leu Asp Ala Pro Thr Gln Ala Arg Ala Trp Pro Gly Gly Gly Ala Val	
325 330 335	
aat acg cag atc cgt gtg gcc tcg gcc gcc gtg cag gaa gcg ccg ttg	1056
Asn Thr Gln Ile Arg Val Ala Ser Ala Ala Val Gln Glu Ala Pro Leu	
340 345 350	
ccg ccg ctc gat gcg gcc ggc cgc gcg tgg gcc gcg cgc ctg caa ccg	1104
Pro Pro Leu Asp Ala Ala Gly Arg Ala Trp Ala Ala Arg Leu Gln Pro	
355 360 365	
gca ttg cac gcg gtc gcg caa acg ctg atc gat cac gag cag acg ctg	1152
Ala Leu His Ala Val Ala Gln Thr Leu Ile Asp His Glu Gln Thr Leu	
370 375 380	
acc gac ctc gat gcg gcg gcc ggc gac ggc gat ctc ggc gcg agc atg	1200
Thr Asp Leu Asp Ala Ala Ala Gly Asp Gly Asp Leu Gly Ala Ser Met	
385 390 395 400	
ctg cgc gcc gcg cag gcg atc ctc gca ctg ccg gaa agc gca tac ggc	1248
Leu Arg Ala Ala Gln Ala Ile Leu Ala Leu Pro Glu Ser Ala Tyr Gly	
405 410 415	

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acg ccg gcc ggc gcg ctc tcg gcg ctc ggc gcc gcg ttg cgc cgc gcg	1296
Thr Pro Ala Gly Ala Leu Ser Ala Leu Gly Ala Ala Leu Arg Arg Ala	
420 425 430	
atc gcc ggc agc tcg ggg ccg ttc tat gcg acc gcg ctg ctg cgc gcg	1344
Ile Ala Gly Ser Ser Gly Pro Phe Tyr Ala Thr Ala Leu Leu Arg Ala	
435 440 445	
tcg cgc cgg ctg gcc gat atc gcc gag ccg tcc gca cgc gac tgg gcc	1392
Ser Arg Arg Leu Ala Asp Ile Ala Glu Pro Ser Ala Arg Asp Trp Ala	
450 455 460	
gcg gcg ttc cgc ggc gcg gtg gat tcg atc agc gaa ctg ggc gcc gcg	1440
Ala Ala Phe Arg Gly Ala Val Asp Ser Ile Ser Glu Leu Gly Gly Ala	
465 470 475 480	
cac gcc ggc gac cgg acc atg ctc gat gcg ctg gtc ccg gcc gtc gcg	1488
His Ala Gly Asp Arg Thr Met Leu Asp Ala Leu Val Pro Ala Val Ala	
485 490 495	
gca ttc gag cgg gcg ctc gac aac gat gcg ctg gtc ccg gcc gca tgg	1536
Ala Phe Glu Arg Ala Leu Asp Asn Asp Arg Asp Pro Ala Gly Ala Trp	
500 505 510	
acg gcc gcg gtc gaa gcc gcc gag cac ggt gcg cag gaa acc gca cgc	1584
Thr Ala Ala Val Glu Ala Ala Glu His Gly Ala Gln Glu Thr Ala Arg	
515 520 525	
atg acg cca cgc gcc ggg cgc gcg agc tat ctc ggc gaa cgt gcg atc	1632
Met Thr Pro Arg Ala Gly Arg Ala Ser Tyr Leu Gly Glu Arg Ala Ile	
530 535 540	
ggc acg ccg gac ggc ggc gcg gtc gcg gtg tcg tat tgg ctg cgt gcg	1680
Gly Thr Pro Asp Gly Gly Ala Val Ala Val Ser Tyr Trp Leu Arg Ala	
545 550 555 560	
ttg cag gca cac atc ggg tga	1701
Leu Gln Ala His Ile Gly	
565	

&lt;210&gt; SEQ ID NO 61

&lt;211&gt; LENGTH: 566

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Burkholderia sp. 383

&lt;400&gt; SEQUENCE: 61

Met Lys Lys Leu Val Asn Arg Pro Ser Asp Val Val Arg Glu Met Leu	
1 5 10 15	
Glu Gly Ile Ala Arg Gln Ser Pro His Val Ala Ile Leu Gly Asp Glu	
20 25 30	
His Val Leu Val Arg Gln Pro Leu Pro Glu Pro Ala Gln Arg Pro Val	
35 40 45	
Ala Ile Leu Ser Gly Gly Gly Ser Gly His Glu Pro Ala His Gly Gly	
50 55 60	
Tyr Val Gly Glu Gly Met Leu Ser Ala Ala Val Cys Gly Glu Val Phe	
65 70 75 80	
Thr Ser Pro Ser Thr Asp Ala Val Leu Ala Ala Ile Arg Ala Ser Ala	
85 90 95	
Gly Pro Asn Gly Ala Leu Leu Ile Val Lys Asn Tyr Thr Gly Asp Arg	
100 105 110	
Leu Asn Phe Gly Leu Ala Ala Glu Leu Ala Arg Ala Glu Gly Ile Pro	
115 120 125	
Val Glu Thr Val Ile Val Ala Asp Asp Val Ser Leu Arg Gly Arg Val	
130 135 140	
Glu Arg Gly Gln Arg Arg Gly Ile Ala Gly Thr Val Leu Ile His Lys	
145 150 155 160	
Leu Ala Gly Ala Ala Ala Ala Arg Gly Leu Pro Leu Ala Arg Val Ala	
165 170 175	



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Ala Ile Ala Arg Asp Ala Ala Ala Glu Leu Gly Thr Met Gly Val Ala  
 180 185 190  
 Leu Asp Gly Cys Thr Ile Pro Gly Ala Asp Lys Ser Gly Phe Ser Leu  
 195 200 205  
 Gly Asp His Glu Ile Glu Leu Gly Leu Gly Ile His Gly Glu Lys Gly  
 210 215 220  
 Val Glu Arg Arg Ala Pro Leu Pro Ala Asp Ala Leu Val Asp Thr Leu  
 225 230 235 240  
 Leu Ser Ser Ile Ala Ala Asp Leu Val Leu Asp Arg Gly Glu Arg Val  
 245 250 255  
 Ala Leu Phe Val Asn Gly Leu Gly Ala Thr Pro Asp Met Glu Leu Ala  
 260 265 270  
 Ile Val Leu Arg Ala Ala His Asp Asn Leu His Arg Arg Gly Ile Val  
 275 280 285  
 Val Ala Arg Ala Trp Ala Gly Thr Phe Leu Ser Ala Leu Asn Met Pro  
 290 295 300  
 Gly Cys Ser Ile Ser Val Leu Arg Leu Asn Asp Glu Arg Ala Val Leu  
 305 310 315 320  
 Leu Asp Ala Pro Thr Gln Ala Arg Ala Trp Pro Gly Gly Gly Ala Val  
 325 330 335  
 Asn Thr Gln Ile Arg Val Ala Ser Ala Ala Val Gln Glu Ala Pro Leu  
 340 345 350  
 Pro Pro Leu Asp Ala Ala Gly Arg Ala Trp Ala Ala Arg Leu Gln Pro  
 355 360 365  
 Ala Leu His Ala Val Ala Gln Thr Leu Ile Asp His Glu Gln Thr Leu  
 370 375 380  
 Thr Asp Leu Asp Ala Ala Ala Gly Asp Gly Asp Leu Gly Ala Ser Met  
 385 390 395 400  
 Leu Arg Ala Ala Gln Ala Ile Leu Ala Leu Pro Glu Ser Ala Tyr Gly  
 405 410 415  
 Thr Pro Ala Gly Ala Leu Ser Ala Leu Gly Ala Ala Leu Arg Arg Ala  
 420 425 430  
 Ile Ala Gly Ser Ser Gly Pro Phe Tyr Ala Thr Ala Leu Leu Arg Ala  
 435 440 445  
 Ser Arg Arg Leu Ala Asp Ile Ala Glu Pro Ser Ala Arg Asp Trp Ala  
 450 455 460  
 Ala Ala Phe Arg Gly Ala Val Asp Ser Ile Ser Glu Leu Gly Gly Ala  
 465 470 475 480  
 His Ala Gly Asp Arg Thr Met Leu Asp Ala Leu Val Pro Ala Val Ala  
 485 490 495  
 Ala Phe Glu Arg Ala Leu Asp Asn Asp Arg Asp Pro Ala Gly Ala Trp  
 500 505 510  
 Thr Ala Ala Val Glu Ala Ala Glu His Gly Ala Gln Glu Thr Ala Arg  
 515 520 525  
 Met Thr Pro Arg Ala Gly Arg Ala Ser Tyr Leu Gly Glu Arg Ala Ile  
 530 535 540  
 Gly Thr Pro Asp Gly Gly Ala Val Ala Val Ser Tyr Trp Leu Arg Ala  
 545 550 555 560  
 Leu Gln Ala His Ile Gly  
 565

&lt;210&gt; SEQ ID NO 62

&lt;211&gt; LENGTH: 1704

&lt;212&gt; TYPE: DNA

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<213> ORGANISM: Burkholderia thailandensis E264
<220> FEATURE:
<221> NAME/KEY: CDS
<222> LOCATION: (1)..(1704)

<400> SEQUENCE: 62

atg aag aag ctc gtc aac cac ccg tcc gac gtc gtg cgc gaa atg ctg      48
Met Lys Lys Leu Val Asn His Pro Ser Asp Val Val Arg Glu Met Leu
1          5          10          15

gag ggc atc gcg cgg cag tcg ccg cat gtc gcg atg ctc ggc gac gaa      96
Glu Gly Ile Ala Arg Gln Ser Pro His Val Ala Met Leu Gly Asp Glu
20          25          30

cac gtg ctg atc cgg cgc ccc ttg ccg gag ccg gcg cgg cgt gcg gtc     144
His Val Leu Ile Arg Arg Pro Leu Pro Glu Pro Ala Arg Arg Ala Val
35          40          45

gcg atc atc tcc ggc ggc ggc agc ggc cac gag ccg gcg cac ggc ggc     192
Ala Ile Ile Ser Gly Gly Gly Ser Gly His Glu Pro Ala His Gly Gly
50          55          60

tac gtc ggc gcg ggg atg ctg agc gcg gcc gtg tgc ggc gag gtc ttc     240
Tyr Val Gly Ala Gly Met Leu Ser Ala Ala Val Cys Gly Glu Val Phe
65          70          75          80

acg tcg ccg ccc gcc gat gcg gtg ctc gcc gcg att cgc gcg acc gcg     288
Thr Ser Pro Pro Ala Asp Ala Val Leu Ala Ala Ile Arg Ala Thr Ala
85          90          95

ggc cag aac ggc gcg ctc ctc atc gtg aag aac tac acg ggc gat cgc     336
Gly Gln Asn Gly Ala Leu Leu Ile Val Lys Asn Tyr Thr Gly Asp Arg
100         105         110

ctc aat ttc ggg ctc gcg gcc gag ctc gcg cgc gcg cag ggc att ccg     384
Leu Asn Phe Gly Leu Ala Ala Glu Leu Ala Arg Ala Gln Gly Ile Pro
115         120         125

gtc gag atc gtc gtc gtc gcg gac gac gtg tcg ctg cgc gaa ctc acc     432
Val Glu Ile Val Val Val Ala Asp Asp Val Ser Leu Arg Glu Leu Thr
130         135         140

gag cgc ggg cgc cgc cgc ggc atc gcc ggc acc gtg ctc gtg cac aag     480
Glu Arg Gly Arg Arg Arg Gly Ile Ala Gly Thr Val Leu Val His Lys
145         150         155         160

ctc gcc ggc gcg gcc gcc gag cgc ggc ctc gcg ctg cgg gag gtg gcc     528
Leu Ala Gly Ala Ala Ala Glu Arg Gly Leu Ala Leu Arg Glu Val Ala
165         170         175

gcc gtc gcg agc gag gcg gcg gcg aat ctc gcc acg atg ggc gtc gca     576
Ala Val Ala Ser Glu Ala Ala Ala Asn Leu Gly Thr Met Gly Val Ala
180         185         190

ctc gac ggc tgc acg att ccg ggc gcc ggg caa tcg ggc ttc cgc ctc     624
Leu Asp Gly Cys Thr Ile Pro Gly Ala Gly Gln Ser Gly Phe Arg Leu
195         200         205

gcc gat cac gag atc gag ctc gga ttg ggc att cac ggc gaa aag ggc     672
Ala Asp His Glu Ile Glu Leu Gly Leu Gly Ile His Gly Glu Lys Gly
210         215         220

gtg cag cgc acg gcg ccg atg ccg gcc gac gcg ctg tcg gaa acg ctc     720
Val Gln Arg Thr Ala Pro Met Pro Ala Asp Ala Leu Ser Glu Thr Leu
225         230         235         240

gtg gcg acg atc gtc gac gat cag gcg atc gcg cgc ggc gat cgg gtc     768
Val Ala Thr Ile Val Asp Asp Gln Ala Ile Ala Arg Gly Asp Arg Val
245         250         255

gcg ctt ctg gtg aac ggg ctc ggc gcg acg ccg gac atg gag ctc ggc     816
Ala Leu Leu Val Asn Gly Leu Gly Ala Thr Pro Asp Met Glu Leu Gly
260         265         270

atc gtg ctg cgc gcg gcg tac gac agc ctg agc cgg cgt ggc gtc gag     864
Ile Val Leu Arg Ala Ala Tyr Asp Ser Leu Ser Arg Arg Gly Val Glu
275         280         285

gtg gcg cgc gcg tgg gcg ggc acg ttc ctg tcc gcg ctc gac atg ccc     912

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Val	Ala	Arg	Ala	Trp	Ala	Gly	Thr	Phe	Leu	Ser	Ala	Leu	Asp	Met	Pro	
	290					295					300					
ggc	tgc	tcg	att	tcg	ctg	ctc	aag	ctg	aac	gat	cgc	atg	ctc	gaa	ctg	960
Gly	Cys	Ser	Ile	Ser	Leu	Leu	Lys	Leu	Asn	Asp	Arg	Met	Leu	Glu	Leu	
305					310					315					320	
ctc	gac	gcg	ccg	acg	caa	gcg	cga	gcg	tgg	ccg	ggc	ggc	ggc	gcg	gtg	1008
Leu	Asp	Ala	Pro	Thr	Gln	Ala	Arg	Ala	Trp	Pro	Gly	Gly	Gly	Ala	Val	
				325					330						335	
aac	cgg	gac	att	cgc	gtg	gcc	gcc	gcc	ggg	acc	ggc	gca	gga	gac	gga	1056
Asn	Arg	Asp	Ile	Arg	Val	Ala	Ala	Ala	Gly	Thr	Gly	Ala	Gly	Asp	Gly	
			340					345						350		
cag	ccg	gaa	tgg	gcg	acg	gcc	ggc	gcg	gcg	ggt	tcc	gac	gga	ctg	cgg	1104
Gln	Pro	Glu	Trp	Ala	Thr	Ala	Gly	Ala	Ala	Gly	Ser	Asp	Gly	Leu	Arg	
		355					360						365			
ccc	gcg	ctg	cat	gcg	gtt	gcc	gcc	gcg	ctg	atc	gac	agc	gag	ccc	gtg	1152
Pro	Ala	Leu	His	Ala	Val	Ala	Ala	Ala	Leu	Ile	Asp	Ser	Glu	Pro	Val	
	370					375					380					
ttg	acc	gag	ctc	gat	tcc	gtc	gcc	ggc	gac	ggc	gat	ctg	ggc	gcg	agc	1200
Leu	Thr	Glu	Leu	Asp	Ser	Val	Ala	Gly	Asp	Gly	Asp	Leu	Gly	Ala	Ser	
385					390					395					400	
atg	cgc	cgc	gcg	gcg	aac	gcg	atg	ctc	gcg	ctg	ccc	gcc	gat	gcg	tat	1248
Met	Arg	Arg	Ala	Ala	Asn	Ala	Met	Leu	Ala	Leu	Pro	Ala	Asp	Ala	Tyr	
			405					410						415		
cga	ggg	ccg	gcg	aac	ctg	ctc	gcc	gcg	ctg	ggc	atg	gcg	ctg	cgc	cgg	1296
Arg	Gly	Pro	Ala	Asn	Leu	Leu	Ala	Ala	Leu	Gly	Met	Ala	Leu	Arg	Arg	
			420					425						430		
gcg	atc	gcg	ggc	agc	tcc	ggg	ccg	ttt	tac	gca	acg	gcg	ctg	gtg	cgc	1344
Ala	Ile	Ala	Gly	Ser	Ser	Gly	Pro	Phe	Tyr	Ala	Thr	Ala	Leu	Val	Arg	
		435					440						445			
gcg	ggc	cgc	cgg	ctc	gcc	gat	gca	tcg	gcg	ccg	acc	gcg	cgc	gac	tgg	1392
Ala	Gly	Arg	Arg	Leu	Ala	Asp	Ala	Ser	Ala	Pro	Thr	Ala	Arg	Asp	Trp	
	450					455					460					
gcg	agc	gcg	ttc	cgg	agc	ggt	gtc	gac	gcg	atc	ggc	gat	ctg	ggc	ggc	1440
Ala	Ser	Ala	Phe	Arg	Ser	Gly	Val	Asp	Ala	Ile	Gly	Asp	Leu	Gly	Gly	
465					470					475					480	
gcg	aag	ccc	gga	gac	cgc	acg	atg	ctc	gac	gcc	ttg	gtg	ccc	gcc	gtc	1488
Ala	Lys	Pro	Gly	Asp	Arg	Thr	Met	Leu	Asp	Ala	Leu	Val	Pro	Ala	Val	
			485					490						495		
gat	gcg	ttc	gag	cac	gcg	ctg	tcg	gcg	ggc	ggg	agc	gcg	agc	gat	gcg	1536
Asp	Ala	Phe	Glu	His	Ala	Leu	Ser	Ala	Gly	Gly	Ser	Ala	Ser	Asp	Ala	
			500					505						510		
tgg	gcg	gcg	gcg	gtg	cgc	gcc	gcg	gag	gca	ggc	gcg	gcg	aaa	acc	gcg	1584
Trp	Ala	Ala	Ala	Val	Arg	Ala	Ala	Glu	Ala	Gly	Ala	Ala	Lys	Thr	Ala	
		515					520						525			
ggc	atg	acg	ccg	cgc	gcg	ggg	cgc	gcg	agc	tat	ctg	ggc	gag	cgc	gcc	1632
Gly	Met	Thr	Pro	Arg	Ala	Gly	Arg	Ala	Ser	Tyr	Leu	Gly	Glu	Arg	Ala	
	530					535							540			
gtg	ggc	tcg	ccc	gac	ggc	ggc	gcg	gtg	gcc	gtg	gcg	tgc	tgg	atg	cgc	1680
Val	Gly	Ser	Pro	Asp	Gly	Gly	Ala	Val	Ala	Val	Ala	Cys	Trp	Met	Arg	
545					550					555					560	
gcg	ttg	cag	ccg	cac	gtc	gcg	tag									1704
Ala	Leu	Gln	Pro	His	Val	Ala										
			565													

&lt;210&gt; SEQ ID NO 63

&lt;211&gt; LENGTH: 567

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Burkholderia thailandensis E264

&lt;400&gt; SEQUENCE: 63

Met Lys Lys Leu Val Asn His Pro Ser Asp Val Val Arg Glu Met Leu

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1	5	10	15
Glu Gly Ile Ala Arg Gln Ser Pro His Val Ala Met Leu Gly Asp Glu	20	25	30
His Val Leu Ile Arg Arg Pro Leu Pro Glu Pro Ala Arg Arg Ala Val	35	40	45
Ala Ile Ile Ser Gly Gly Gly Ser Gly His Glu Pro Ala His Gly Gly	50	55	60
Tyr Val Gly Ala Gly Met Leu Ser Ala Ala Val Cys Gly Glu Val Phe	65	70	75
Thr Ser Pro Pro Ala Asp Ala Val Leu Ala Ala Ile Arg Ala Thr Ala	85	90	95
Gly Gln Asn Gly Ala Leu Leu Ile Val Lys Asn Tyr Thr Gly Asp Arg	100	105	110
Leu Asn Phe Gly Leu Ala Ala Glu Leu Ala Arg Ala Gln Gly Ile Pro	115	120	125
Val Glu Ile Val Val Val Ala Asp Asp Val Ser Leu Arg Glu Leu Thr	130	135	140
Glu Arg Gly Arg Arg Arg Gly Ile Ala Gly Thr Val Leu Val His Lys	145	150	155
Leu Ala Gly Ala Ala Ala Glu Arg Gly Leu Ala Leu Arg Glu Val Ala	165	170	175
Ala Val Ala Ser Glu Ala Ala Ala Asn Leu Gly Thr Met Gly Val Ala	180	185	190
Leu Asp Gly Cys Thr Ile Pro Gly Ala Gly Gln Ser Gly Phe Arg Leu	195	200	205
Ala Asp His Glu Ile Glu Leu Gly Leu Gly Ile His Gly Glu Lys Gly	210	215	220
Val Gln Arg Thr Ala Pro Met Pro Ala Asp Ala Leu Ser Glu Thr Leu	225	230	235
Val Ala Thr Ile Val Asp Asp Gln Ala Ile Ala Arg Gly Asp Arg Val	245	250	255
Ala Leu Leu Val Asn Gly Leu Gly Ala Thr Pro Asp Met Glu Leu Gly	260	265	270
Ile Val Leu Arg Ala Ala Tyr Asp Ser Leu Ser Arg Arg Gly Val Glu	275	280	285
Val Ala Arg Ala Trp Ala Gly Thr Phe Leu Ser Ala Leu Asp Met Pro	290	295	300
Gly Cys Ser Ile Ser Leu Leu Lys Leu Asn Asp Arg Met Leu Glu Leu	305	310	315
Leu Asp Ala Pro Thr Gln Ala Arg Ala Trp Pro Gly Gly Gly Ala Val	325	330	335
Asn Arg Asp Ile Arg Val Ala Ala Ala Gly Thr Gly Ala Gly Asp Gly	340	345	350
Gln Pro Glu Trp Ala Thr Ala Gly Ala Ala Gly Ser Asp Gly Leu Arg	355	360	365
Pro Ala Leu His Ala Val Ala Ala Ala Leu Ile Asp Ser Glu Pro Val	370	375	380
Leu Thr Glu Leu Asp Ser Val Ala Gly Asp Gly Asp Leu Gly Ala Ser	385	390	395
Met Arg Arg Ala Ala Asn Ala Met Leu Ala Leu Pro Ala Asp Ala Tyr	405	410	415
Arg Gly Pro Ala Asn Leu Leu Ala Ala Leu Gly Met Ala Leu Arg Arg	420	425	430



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Ala Ile Ala Gly Ser Ser Gly Pro Phe Tyr Ala Thr Ala Leu Val Arg  
 435 440 445

Ala Gly Arg Arg Leu Ala Asp Ala Ser Ala Pro Thr Ala Arg Asp Trp  
 450 455 460

Ala Ser Ala Phe Arg Ser Gly Val Asp Ala Ile Gly Asp Leu Gly Gly  
 465 470 475 480

Ala Lys Pro Gly Asp Arg Thr Met Leu Asp Ala Leu Val Pro Ala Val  
 485 490 495

Asp Ala Phe Glu His Ala Leu Ser Ala Gly Gly Ser Ala Ser Asp Ala  
 500 505 510

Trp Ala Ala Ala Val Arg Ala Ala Glu Ala Gly Ala Ala Lys Thr Ala  
 515 520 525

Gly Met Thr Pro Arg Ala Gly Arg Ala Ser Tyr Leu Gly Glu Arg Ala  
 530 535 540

Val Gly Ser Pro Asp Gly Gly Ala Val Ala Val Ala Cys Trp Met Arg  
 545 550 555 560

Ala Leu Gln Pro His Val Ala  
 565

<210> SEQ ID NO 64  
 <211> LENGTH: 1851  
 <212> TYPE: DNA  
 <213> ORGANISM: Burkholderia multivorans  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1851)

<400> SEQUENCE: 64

atg tat cgt ggc acc gaa gcg cgc acc ggc gag atc cat ggc act gct 48  
 Met Tyr Arg Gly Thr Glu Ala Arg Thr Gly Glu Ile His Gly Thr Ala  
 1 5 10 15

cca cgc cac cgc cgc cac ggc gcg cgc att ccc gca acc cga cag ccc 96  
 Pro Arg His Arg Arg His Gly Ala Arg Ile Pro Ala Thr Arg Gln Pro  
 20 25 30

gag gcg ccg gat cgg ttc ggc ccg cgg gct ttc atc tgc ccg gaa acc 144  
 Glu Ala Pro Asp Arg Phe Gly Pro Arg Ala Phe Ile Cys Pro Glu Thr  
 35 40 45

gtc gcc atg aaa aaa ctc gtg aac cgt ccg tcc gac gtc gtg cgt gaa 192  
 Val Ala Met Lys Lys Leu Val Asn Arg Pro Ser Asp Val Val Arg Glu  
 50 55 60

atg ctc gaa ggc att gcg cga cag tcg ccg cat ctc gcg atg ctc ggc 240  
 Met Leu Glu Gly Ile Ala Arg Gln Ser Pro His Leu Ala Met Leu Gly  
 65 70 75 80

gac gag cac gtg ctc gtc cgc cgc ccg ctg ccc gaa ccg tcg cag cgc 288  
 Asp Glu His Val Leu Val Arg Arg Pro Leu Pro Glu Pro Ser Gln Arg  
 85 90 95

acg gtt gcg gtg ctg tcg ggc ggc ggc agc ggg cac gag cct gcg cac 336  
 Thr Val Ala Val Leu Ser Gly Gly Gly Ser Gly His Glu Pro Ala His  
 100 105 110

ggc ggc tat gtc ggc gac gga atg ctc agt gcg gcc gtg tgc ggc gaa 384  
 Gly Gly Tyr Val Gly Asp Gly Met Leu Ser Ala Ala Val Cys Gly Glu  
 115 120 125

gtg ttc acg tcg ccg tcc acc gac gcg gtg ctc gcc gcg atc cgc gcg 432  
 Val Phe Thr Ser Pro Ser Thr Asp Ala Val Leu Ala Ala Ile Arg Ala  
 130 135 140

acg gcc ggc ccg aac ggc gcg ctg ctc gtc gtg aag aac tac acc ggc 480  
 Thr Ala Gly Pro Asn Gly Ala Leu Leu Val Val Lys Asn Tyr Thr Gly  
 145 150 155 160

gac cgg ctc aac ttc ggt ctg gca gcc gaa ctc gcg cgc gca gaa ggc 528  
 Asp Arg Leu Asn Phe Gly Leu Ala Ala Glu Leu Ala Arg Ala Glu Gly

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165				170				175								
att	ccg	gtc	gag	acc	gtg	atc	gtc	gcg	gac	gac	gta	tcg	ctg	cgc	ggc	576
Ile	Pro	Val	Glu	Thr	Val	Ile	Val	Ala	Asp	Asp	Val	Ser	Leu	Arg	Gly	
			180					185					190			
cgc	gtc	gag	cgc	gga	cag	cgg	cgc	ggc	atc	gcg	ggc	acc	gtg	ctg	atc	624
Arg	Val	Glu	Arg	Gly	Gln	Arg	Arg	Gly	Ile	Ala	Gly	Thr	Val	Leu	Ile	
			195					200					205			
cac	aag	ctc	gcg	ggc	gcg	gcg	gcc	gcg	cgc	ggg	ctg	tcg	ctg	ccg	cgc	672
His	Lys	Leu	Ala	Gly	Ala	Ala	Ala	Ala	Arg	Gly	Leu	Ser	Leu	Pro	Arg	
			210					215					220			
gtc	gcg	gcg	atc	gcg	cgc	gat	gcg	gcc	gcc	gat	ctc	ggc	acg	atg	ggc	720
Val	Ala	Ala	Ile	Ala	Arg	Asp	Ala	Ala	Ala	Asp	Leu	Gly	Thr	Met	Gly	
			225				230						235			240
gtc	gcg	ctc	gac	ggc	tgt	acg	ctg	ccg	ggc	gcc	gac	cag	tcc	gga	ttc	768
Val	Ala	Leu	Asp	Gly	Cys	Thr	Leu	Pro	Gly	Ala	Asp	Gln	Ser	Gly	Phe	
				245											255	
agc	ctc	gcc	gac	gac	gaa	atc	gag	ctc	ggt	ctc	ggc	att	cat	ggc	gaa	816
Ser	Leu	Ala	Asp	Asp	Glu	Ile	Glu	Leu	Gly	Leu	Gly	Ile	His	Gly	Glu	
				260											270	
aaa	ggc	gtc	gaa	cgc	acg	gcg	ccg	ctg	ccg	gcc	gac	gcg	ctc	gcc	gat	864
Lys	Gly	Val	Glu	Arg	Thr	Ala	Pro	Leu	Pro	Ala	Asp	Ala	Leu	Ala	Asp	
			275					280							285	
acg	ctg	ctg	tcc	ggg	atc	gtc	gcc	gac	ctc	gtg	ctc	gat	cgc	ggc	gaa	912
Thr	Leu	Leu	Ser	Gly	Ile	Val	Ala	Asp	Leu	Val	Leu	Asp	Arg	Gly	Glu	
				290				295							300	
cgc	gtc	gcg	ctg	ctc	gtc	aac	ggt	ctc	ggc	gcg	acg	ccc	gac	atg	gag	960
Arg	Val	Ala	Leu	Leu	Val	Asn	Gly	Leu	Gly	Ala	Thr	Pro	Asp	Met	Glu	
								310							320	
ctt	gcg	atc	gtg	ctg	cgc	gcc	gcc	tac	gag	aac	ctg	agc	cgt	cgc	ggc	1008
Leu	Ala	Ile	Val	Leu	Arg	Ala	Ala	Tyr	Glu	Asn	Leu	Ser	Arg	Arg	Gly	
															335	
atc	gcg	gtc	gag	cgc	gcg	tgg	gcc	ggt	acg	ttc	ctg	tcg	gcg	ctg	aac	1056
Ile	Ala	Val	Glu	Arg	Ala	Trp	Ala	Gly	Thr	Phe	Leu	Ser	Ala	Leu	Asn	
															350	
atg	ccc	ggc	tgt	tcg	atc	tcg	gtg	ctg	cgg	ctc	gac	gac	gag	cgg	gcg	1104
Met	Pro	Gly	Cys	Ser	Ile	Ser	Val	Leu	Arg	Leu	Asp	Asp	Glu	Arg	Ala	
															365	
gcg	ctg	ctc	gac	gca	ccg	acg	caa	gcg	cgc	gcg	tgg	ccc	ggc	ggc	ggc	1152
Ala	Leu	Leu	Asp	Ala	Pro	Thr	Gln	Ala	Arg	Ala	Trp	Pro	Gly	Gly	Gly	
															380	
gcc	gtc	aac	gca	cag	atc	cgc	atc	gcc	gcc	gcg	gcg	ccg	cag	gaa	ccg	1200
Ala	Val	Asn	Ala	Gln	Ile	Arg	Ile	Ala	Ala	Ala	Ala	Pro	Gln	Glu	Pro	
															400	
tcg	ccg	ccg	ccg	ctc	gac	gcg	gcg	ggc	cgc	gtg	tgg	gcc	gag	cgg	ctg	1248
Ser	Pro	Pro	Pro	Leu	Asp	Ala	Ala	Gly	Arg	Val	Trp	Ala	Glu	Arg	Leu	
															415	
cgc	ccg	gcg	ctg	cac	gcg	gtc	gcg	cac	acg	ctg	atc	gac	cac	gaa	gca	1296
Arg	Pro	Ala	Leu	His	Ala	Val	Ala	His	Thr	Leu	Ile	Asp	His	Glu	Ala	
															430	
acg	ctg	acc	gag	ctc	gat	gcc	gcc	gcc	ggc	gac	ggc	gac	ctc	ggc	gcg	1344
Thr	Leu	Thr	Glu	Leu	Asp	Ala	Ala	Ala	Gly	Asp	Gly	Asp	Leu	Gly	Ala	
															445	
agc	atg	cgt	cgt	gcc	gcg	gac	gcg	atg	ctc	gcg	ttg	ccg	gaa	acc	gcg	1392
Ser	Met	Arg	Arg	Ala	Ala	Asp	Ala	Met	Leu	Ala	Leu	Pro	Glu	Thr	Ala	
															460	
tat	gcg	acg	ccg	gcc	ggt	gcg	ctc	gcc	gcg	ctc	ggc	gcc	gcg	ctg	cgc	1440
Tyr	Ala	Thr	Pro	Ala	Gly	Ala	Leu	Ala	Ala	Leu	Gly	Ala	Ala	Leu	Arg	
															480	
cgt	gcg	atc	gcg	ggc	agc	tcg	ggc	ccc	ttc	tac	gcg	acc	gcg	ctg	ctg	1488
Arg	Ala	Ile	Ala	Gly	Ser	Ser	Gly	Pro	Phe	Tyr	Ala	Thr	Ala	Leu	Leu	



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485	490	495	
cgc gca tcg cgg cgc ctg gcc ggc ctc gcg cag ccg tcg gca cgc gac Arg Ala Ser Arg Arg Leu Ala Gly Leu Ala Gln Pro Ser Ala Arg Asp 500 505 510			1536
tgg gcc gcg gca ttg cgc agc gca gcc gat gcg atc gcc gaa ctc ggc Trp Ala Ala Ala Leu Arg Ser Ala Ala Asp Ala Ile Ala Glu Leu Gly 515 520 525			1584
ggc gcc cgt gcc ggt gac aga acg atg ctc gac gcg ctg gtg ccg gcc Gly Ala Arg Ala Gly Asp Arg Thr Met Leu Asp Ala Leu Val Pro Ala 530 535 540			1632
gcc gcc gcg ttc gac cgt gca ctc gac gac ggt cgc gac agc gcc ggc Ala Ala Ala Phe Asp Arg Ala Leu Asp Asp Gly Arg Asp Ser Ala Gly 545 550 555 560			1680
gcg tgg gcg gcc gcc gtc gac gcc gcc gag cgc ggt gcg cag gac acc Ala Trp Ala Ala Ala Val Asp Ala Ala Glu Arg Gly Ala Gln Asp Thr 565 570 575			1728
gcg cgc atg acg ccg cgc gcg ggc cgt gcg agc tat ctc ggc gaa cgc Ala Arg Met Thr Pro Arg Ala Gly Arg Ala Ser Tyr Leu Gly Glu Arg 580 585 590			1776
gcg atc ggc acg ccc gac ggc ggc gcc atc gcc gtc gcg tac tgg ctg Ala Ile Gly Thr Pro Asp Gly Gly Ala Ile Ala Val Ala Tyr Trp Leu 595 600 605			1824
cgc gca ctg ctg ccg cac gtc cga taa Arg Ala Leu Leu Pro His Val Arg 610 615			1851

&lt;210&gt; SEQ ID NO 65

&lt;211&gt; LENGTH: 616

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Burkholderia multivorans

&lt;400&gt; SEQUENCE: 65

Met Tyr Arg Gly Thr Glu Ala Arg Thr Gly Glu Ile His Gly Thr Ala 1 5 10 15
Pro Arg His Arg Arg His Gly Ala Arg Ile Pro Ala Thr Arg Gln Pro 20 25 30
Glu Ala Pro Asp Arg Phe Gly Pro Arg Ala Phe Ile Cys Pro Glu Thr 35 40 45
Val Ala Met Lys Lys Leu Val Asn Arg Pro Ser Asp Val Val Arg Glu 50 55 60
Met Leu Glu Gly Ile Ala Arg Gln Ser Pro His Leu Ala Met Leu Gly 65 70 75 80
Asp Glu His Val Leu Val Arg Arg Pro Leu Pro Glu Pro Ser Gln Arg 85 90 95
Thr Val Ala Val Leu Ser Gly Gly Gly Ser Gly His Glu Pro Ala His 100 105 110
Gly Gly Tyr Val Gly Asp Gly Met Leu Ser Ala Ala Val Cys Gly Glu 115 120 125
Val Phe Thr Ser Pro Ser Thr Asp Ala Val Leu Ala Ala Ile Arg Ala 130 135 140
Thr Ala Gly Pro Asn Gly Ala Leu Leu Val Val Lys Asn Tyr Thr Gly 145 150 155 160
Asp Arg Leu Asn Phe Gly Leu Ala Ala Glu Leu Ala Arg Ala Glu Gly 165 170 175
Ile Pro Val Glu Thr Val Ile Val Ala Asp Asp Val Ser Leu Arg Gly 180 185 190
Arg Val Glu Arg Gly Gln Arg Arg Gly Ile Ala Gly Thr Val Leu Ile 195 200 205

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His Lys Leu Ala Gly Ala Ala Ala Ala Arg Gly Leu Ser Leu Pro Arg  
 210 215 220  
 Val Ala Ala Ile Ala Arg Asp Ala Ala Ala Asp Leu Gly Thr Met Gly  
 225 230 235 240  
 Val Ala Leu Asp Gly Cys Thr Leu Pro Gly Ala Asp Gln Ser Gly Phe  
 245 250 255  
 Ser Leu Ala Asp Asp Glu Ile Glu Leu Gly Leu Gly Ile His Gly Glu  
 260 265 270  
 Lys Gly Val Glu Arg Thr Ala Pro Leu Pro Ala Asp Ala Leu Ala Asp  
 275 280 285  
 Thr Leu Leu Ser Gly Ile Val Ala Asp Leu Val Leu Asp Arg Gly Glu  
 290 295 300  
 Arg Val Ala Leu Leu Val Asn Gly Leu Gly Ala Thr Pro Asp Met Glu  
 305 310 315 320  
 Leu Ala Ile Val Leu Arg Ala Ala Tyr Glu Asn Leu Ser Arg Arg Gly  
 325 330 335  
 Ile Ala Val Glu Arg Ala Trp Ala Gly Thr Phe Leu Ser Ala Leu Asn  
 340 345 350  
 Met Pro Gly Cys Ser Ile Ser Val Leu Arg Leu Asp Asp Glu Arg Ala  
 355 360 365  
 Ala Leu Leu Asp Ala Pro Thr Gln Ala Arg Ala Trp Pro Gly Gly Gly  
 370 375 380  
 Ala Val Asn Ala Gln Ile Arg Ile Ala Ala Ala Ala Pro Gln Glu Pro  
 385 390 395 400  
 Ser Pro Pro Pro Leu Asp Ala Ala Gly Arg Val Trp Ala Glu Arg Leu  
 405 410 415  
 Arg Pro Ala Leu His Ala Val Ala His Thr Leu Ile Asp His Glu Ala  
 420 425 430  
 Thr Leu Thr Glu Leu Asp Ala Ala Ala Gly Asp Gly Asp Leu Gly Ala  
 435 440 445  
 Ser Met Arg Arg Ala Ala Asp Ala Met Leu Ala Leu Pro Glu Thr Ala  
 450 455 460  
 Tyr Ala Thr Pro Ala Gly Ala Leu Ala Ala Leu Gly Ala Ala Leu Arg  
 465 470 475 480  
 Arg Ala Ile Ala Gly Ser Ser Gly Pro Phe Tyr Ala Thr Ala Leu Leu  
 485 490 495  
 Arg Ala Ser Arg Arg Leu Ala Gly Leu Ala Gln Pro Ser Ala Arg Asp  
 500 505 510  
 Trp Ala Ala Ala Leu Arg Ser Ala Ala Asp Ala Ile Ala Glu Leu Gly  
 515 520 525  
 Gly Ala Arg Ala Gly Asp Arg Thr Met Leu Asp Ala Leu Val Pro Ala  
 530 535 540  
 Ala Ala Ala Phe Asp Arg Ala Leu Asp Asp Gly Arg Asp Ser Ala Gly  
 545 550 555 560  
 Ala Trp Ala Ala Ala Val Asp Ala Ala Glu Arg Gly Ala Gln Asp Thr  
 565 570 575  
 Ala Arg Met Thr Pro Arg Ala Gly Arg Ala Ser Tyr Leu Gly Glu Arg  
 580 585 590  
 Ala Ile Gly Thr Pro Asp Gly Gly Ala Ile Ala Val Ala Tyr Trp Leu  
 595 600 605  
 Arg Ala Leu Leu Pro His Val Arg  
 610 615



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<210> SEQ ID NO 66
<211> LENGTH: 1920
<212> TYPE: DNA
<213> ORGANISM: Escherichia coli
<220> FEATURE:
<221> NAME/KEY: CDS
<222> LOCATION: (1)..(1920)

<400> SEQUENCE: 66

atg agt ggc gct ttt aac aac gat ggt cgg ggc ata tct ccc tta att      48
Met Ser Gly Ala Phe Asn Asn Asp Gly Arg Gly Ile Ser Pro Leu Ile
1           5           10           15

gca acc tcc tgg gag cga tgc aat aag ctg atg aaa cgg gag aca tgg      96
Ala Thr Ser Trp Glu Arg Cys Asn Lys Leu Met Lys Arg Glu Thr Trp
20           25           30

aac gta cca cat cag gcc cag ggc gtg aca ttt gct tct att tat cgg     144
Asn Val Pro His Gln Ala Gln Gly Val Thr Phe Ala Ser Ile Tyr Arg
35           40           45

cgt aag aaa gcg atg ctg acg ctc ggg cag gct gcg ctg gaa gat gcc     192
Arg Lys Lys Ala Met Leu Thr Leu Gly Gln Ala Ala Leu Glu Asp Ala
50           55           60

tgg gaa tat atg gca ccg cga gag tgt gcg ctg ttt atc ctc gat gaa     240
Trp Glu Tyr Met Ala Pro Arg Glu Cys Ala Leu Phe Ile Leu Asp Glu
65           70           75           80

acc gcc tgc att ctc agc cgt aat ggc gat ccg caa acc ttg cag cag     288
Thr Ala Cys Ile Leu Ser Arg Asn Gly Asp Pro Gln Thr Leu Gln Gln
85           90           95

cta agt gca ctg gga ttc aat gac ggc acg tat tgc gcc gag gga att     336
Leu Ser Ala Leu Gly Phe Asn Asp Gly Thr Tyr Cys Ala Glu Gly Ile
100          105          110

att ggt act tgt gcg cta tcg tta gcg gct atc tct ggt cag gcc gtg     384
Ile Gly Thr Cys Ala Leu Ser Leu Ala Ala Ile Ser Gly Gln Ala Val
115          120          125

aaa acg atg gcc gat caa cat ttc aaa cag gta ctc tgg aac tgg gcc     432
Lys Thr Met Ala Asp Gln His Phe Lys Gln Val Leu Trp Asn Trp Ala
130          135          140

ttt tgt gca acg ccg ttg ttt gac agc aag ggc cga ttg acg gga aca     480
Phe Cys Ala Thr Pro Leu Phe Asp Ser Lys Gly Arg Leu Thr Gly Thr
145          150          155          160

ata gcg ctg gcg tgt ccg gtt gag caa act acc gca gct gat ttg ccg     528
Ile Ala Leu Ala Cys Pro Val Glu Gln Thr Thr Ala Ala Asp Leu Pro
165          170          175

ttg acg ttg gca atc gcc cgc gag gtc gga aat tta ctg ctg acg gac     576
Leu Thr Leu Ala Ile Ala Arg Glu Val Gly Asn Leu Leu Leu Thr Asp
180          185          190

agt ttg ctc gct gaa act aac cgt cat tta aat caa ctt aat gcc ctg     624
Ser Leu Leu Ala Glu Thr Asn Arg His Leu Asn Gln Leu Asn Ala Leu
195          200          205

tta gaa agt atg gat gat ggc gtg att agc tgg gac gag cag ggt aat     672
Leu Glu Ser Met Asp Asp Gly Val Ile Ser Trp Asp Glu Gln Gly Asn
210          215          220

ttg caa ttt att aat gcc cag gcg gcg cgg gtc ttg cgc ctt gac gcg     720
Leu Gln Phe Ile Asn Ala Gln Ala Ala Arg Val Leu Arg Leu Asp Ala
225          230          235          240

acg gca agt cag gga cgg gca atc act gaa ctc tta acg tta ccc gcc     768
Thr Ala Ser Gln Gly Arg Ala Ile Thr Glu Leu Leu Thr Leu Pro Ala
245          250          255

gta ttg caa caa gca ata aaa cag gca cat ccg ctc aaa cac gta gaa     816
Val Leu Gln Gln Ala Ile Lys Gln Ala His Pro Leu Lys His Val Glu
260          265          270

gca acc ttt gaa agc cag cac cag ttt att gat gcg gtg ata acc ctt     864
Ala Thr Phe Glu Ser Gln His Gln Phe Ile Asp Ala Val Ile Thr Leu

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275	280	285	
aaa ccg ata ata gaa acg cag gga acc agc ttt att ttg ttg ctc cat Lys Pro Ile Ile Glu Thr Gln Gly Thr Ser Phe Ile Leu Leu Leu His 290 295 300			912
cct gtg gaa cag atg cgg cag ttg atg acc agt caa tta gga aaa gtc Pro Val Glu Gln Met Arg Gln Leu Met Thr Ser Gln Leu Gly Lys Val 305 310 315 320			960
agc cat acc ttc gct cat atg cca cag gac gat ccg caa acc cgc cgc Ser His Thr Phe Ala His Met Pro Gln Asp Asp Pro Gln Thr Arg Arg 325 330 335			1008
ttg att cat ttt ggt cgc cag gcg gcg cgc agt agc ttt cct gtc ctg Leu Ile His Phe Gly Arg Gln Ala Ala Arg Ser Ser Phe Pro Val Leu 340 345 350			1056
ctt tgt gga gaa gag ggc gtg ggc aag gca ctg cta agt cag gca att Leu Cys Gly Glu Glu Gly Val Gly Lys Ala Leu Leu Ser Gln Ala Ile 355 360 365			1104
cat aat gaa agc gag cgt gct gca ggt cct tat atc gcc gtc aat tgt His Asn Glu Ser Glu Arg Ala Ala Gly Pro Tyr Ile Ala Val Asn Cys 370 375 380			1152
gag tta tat ggt gat gct gcg ctg gcg gaa gaa ttt att ggt ggc gat Glu Leu Tyr Gly Asp Ala Ala Leu Ala Glu Glu Phe Ile Gly Gly Asp 385 390 395 400			1200
cgc acg gac aat gaa aat ggc cgt ctg agt cgg ctg gaa ctg gca cac Arg Thr Asp Asn Glu Asn Gly Arg Leu Ser Arg Leu Glu Leu Ala His 405 410 415			1248
ggc ggc acg ctg ttt ctt gaa aag att gaa tat ctg gcg gtg gag tta Gly Gly Thr Leu Phe Leu Glu Lys Ile Glu Tyr Leu Ala Val Glu Leu 420 425 430			1296
cag tct gct ttg ctt cag gtt atc aag cag ggg gtt atc acg cga ctg Gln Ser Ala Leu Leu Gln Val Ile Lys Gln Gly Val Ile Thr Arg Leu 435 440 445			1344
gat gcg cgg cgt tta ata cca att gat gtc aaa gtg att gca aca acg Asp Ala Arg Arg Leu Ile Pro Ile Asp Val Lys Val Ile Ala Thr Thr 450 455 460			1392
acc gcg gac ctc gca atg ctg gtg gaa caa aat cgt ttt agt cgc cag Thr Ala Asp Leu Ala Met Leu Val Glu Gln Asn Arg Phe Ser Arg Gln 465 470 475 480			1440
ctg tat tac gcg ctg cat gca ttt gaa att acc atc ccg cct ctg cgt Leu Tyr Tyr Ala Leu His Ala Phe Glu Ile Thr Ile Pro Pro Leu Arg 485 490 495			1488
atg cgg cgt ggc agc att ccg gcg ctg gtg aat aac aaa tta cgc agt Met Arg Arg Gly Ser Ile Pro Ala Leu Val Asn Asn Lys Leu Arg Ser 500 505 510			1536
ctt gaa aaa cgc ttc tct acg cgg ctg aaa att gat gac gat gcc ctc Leu Glu Lys Arg Phe Ser Thr Arg Leu Lys Ile Asp Asp Asp Ala Leu 515 520 525			1584
gct cgc ctg gtt tct tgt gca tgg cca ggc aac gat ttt gaa ctt tac Ala Arg Leu Val Ser Cys Ala Trp Pro Gly Asn Asp Phe Glu Leu Tyr 530 535 540			1632
agc gtc atc gag aat ctt gct ctg agt agt gat aac ggg cgc att cgc Ser Val Ile Glu Asn Leu Ala Leu Ser Ser Asp Asn Gly Arg Ile Arg 545 550 555 560			1680
gtc agt gat ttg ccg gaa cat ctg ttt acc gag cag gcg aca gat gat Val Ser Asp Leu Pro Glu His Leu Phe Thr Glu Gln Ala Thr Asp Asp 565 570 575			1728
gtc agc gcc acc cgc ctt tcc acc agt ctg tca ttt gcg gaa gtt gaa Val Ser Ala Thr Arg Leu Ser Thr Ser Leu Ser Phe Ala Glu Val Glu 580 585 590			1776
aaa gag gca att att aac gca gcc cag gtc aca ggc ggt cgc att cag Lys Glu Ala Ile Ile Asn Ala Ala Gln Val Thr Gly Gly Arg Ile Gln			1824



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595	600	605	
gaa atg tcg gct tta ctt ggg atc ggc cgc act acg ctg tgg cgg aaa			1872
Glu Met Ser Ala Leu Leu Gly Ile Gly Arg Thr Thr Leu Trp Arg Lys			
610	615	620	
atg aag caa cat ggc att gat gca ggg cag ttt aag cgc cgg gta tga			1920
Met Lys Gln His Gly Ile Asp Ala Gly Gln Phe Lys Arg Arg Val			
625	630	635	
<210> SEQ ID NO 67			
<211> LENGTH: 639			
<212> TYPE: PRT			
<213> ORGANISM: Escherichia coli			
<400> SEQUENCE: 67			
Met Ser Gly Ala Phe Asn Asn Asp Gly Arg Gly Ile Ser Pro Leu Ile			
1	5	10	15
Ala Thr Ser Trp Glu Arg Cys Asn Lys Leu Met Lys Arg Glu Thr Trp			
	20	25	30
Asn Val Pro His Gln Ala Gln Gly Val Thr Phe Ala Ser Ile Tyr Arg			
	35	40	45
Arg Lys Lys Ala Met Leu Thr Leu Gly Gln Ala Ala Leu Glu Asp Ala			
	50	55	60
Trp Glu Tyr Met Ala Pro Arg Glu Cys Ala Leu Phe Ile Leu Asp Glu			
65	70	75	80
Thr Ala Cys Ile Leu Ser Arg Asn Gly Asp Pro Gln Thr Leu Gln Gln			
	85	90	95
Leu Ser Ala Leu Gly Phe Asn Asp Gly Thr Tyr Cys Ala Glu Gly Ile			
	100	105	110
Ile Gly Thr Cys Ala Leu Ser Leu Ala Ala Ile Ser Gly Gln Ala Val			
	115	120	125
Lys Thr Met Ala Asp Gln His Phe Lys Gln Val Leu Trp Asn Trp Ala			
	130	135	140
Phe Cys Ala Thr Pro Leu Phe Asp Ser Lys Gly Arg Leu Thr Gly Thr			
145	150	155	160
Ile Ala Leu Ala Cys Pro Val Glu Gln Thr Thr Ala Ala Asp Leu Pro			
	165	170	175
Leu Thr Leu Ala Ile Ala Arg Glu Val Gly Asn Leu Leu Leu Thr Asp			
	180	185	190
Ser Leu Leu Ala Glu Thr Asn Arg His Leu Asn Gln Leu Asn Ala Leu			
	195	200	205
Leu Glu Ser Met Asp Asp Gly Val Ile Ser Trp Asp Glu Gln Gly Asn			
	210	215	220
Leu Gln Phe Ile Asn Ala Gln Ala Ala Arg Val Leu Arg Leu Asp Ala			
225	230	235	240
Thr Ala Ser Gln Gly Arg Ala Ile Thr Glu Leu Leu Thr Leu Pro Ala			
	245	250	255
Val Leu Gln Gln Ala Ile Lys Gln Ala His Pro Leu Lys His Val Glu			
	260	265	270
Ala Thr Phe Glu Ser Gln His Gln Phe Ile Asp Ala Val Ile Thr Leu			
	275	280	285
Lys Pro Ile Ile Glu Thr Gln Gly Thr Ser Phe Ile Leu Leu Leu His			
	290	295	300
Pro Val Glu Gln Met Arg Gln Leu Met Thr Ser Gln Leu Gly Lys Val			
305	310	315	320
Ser His Thr Phe Ala His Met Pro Gln Asp Asp Pro Gln Thr Arg Arg			
	325	330	335

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Leu Ile His Phe Gly Arg Gln Ala Ala Arg Ser Ser Phe Pro Val Leu  
 340 345 350

Leu Cys Gly Glu Glu Gly Val Gly Lys Ala Leu Leu Ser Gln Ala Ile  
 355 360 365

His Asn Glu Ser Glu Arg Ala Ala Gly Pro Tyr Ile Ala Val Asn Cys  
 370 375 380

Glu Leu Tyr Gly Asp Ala Ala Leu Ala Glu Glu Phe Ile Gly Gly Asp  
 385 390 395 400

Arg Thr Asp Asn Glu Asn Gly Arg Leu Ser Arg Leu Glu Leu Ala His  
 405 410 415

Gly Gly Thr Leu Phe Leu Glu Lys Ile Glu Tyr Leu Ala Val Glu Leu  
 420 425 430

Gln Ser Ala Leu Leu Gln Val Ile Lys Gln Gly Val Ile Thr Arg Leu  
 435 440 445

Asp Ala Arg Arg Leu Ile Pro Ile Asp Val Lys Val Ile Ala Thr Thr  
 450 455 460

Thr Ala Asp Leu Ala Met Leu Val Glu Gln Asn Arg Phe Ser Arg Gln  
 465 470 475 480

Leu Tyr Tyr Ala Leu His Ala Phe Glu Ile Thr Ile Pro Pro Leu Arg  
 485 490 495

Met Arg Arg Gly Ser Ile Pro Ala Leu Val Asn Asn Lys Leu Arg Ser  
 500 505 510

Leu Glu Lys Arg Phe Ser Thr Arg Leu Lys Ile Asp Asp Ala Leu  
 515 520 525

Ala Arg Leu Val Ser Cys Ala Trp Pro Gly Asn Asp Phe Glu Leu Tyr  
 530 535 540

Ser Val Ile Glu Asn Leu Ala Leu Ser Ser Asp Asn Gly Arg Ile Arg  
 545 550 555 560

Val Ser Asp Leu Pro Glu His Leu Phe Thr Glu Gln Ala Thr Asp Asp  
 565 570 575

Val Ser Ala Thr Arg Leu Ser Thr Ser Leu Ser Phe Ala Glu Val Glu  
 580 585 590

Lys Glu Ala Ile Ile Asn Ala Ala Gln Val Thr Gly Gly Arg Ile Gln  
 595 600 605

Glu Met Ser Ala Leu Leu Gly Ile Gly Arg Thr Thr Leu Trp Arg Lys  
 610 615 620

Met Lys Gln His Gly Ile Asp Ala Gly Gln Phe Lys Arg Arg Val  
 625 630 635

<210> SEQ ID NO 68  
 <211> LENGTH: 663  
 <212> TYPE: DNA  
 <213> ORGANISM: Escherichia coli  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(663)

<400> SEQUENCE: 68

atg gaa ctg tat ctg gat act tca gac gtt gtt gcg gtg aag gcg ctg 48  
 Met Glu Leu Tyr Leu Asp Thr Ser Asp Val Val Ala Val Lys Ala Leu  
 1 5 10 15

tca cgt att ttt ccg ctg gcg ggt gtg acc act aac cca agc att atc 96  
 Ser Arg Ile Phe Pro Leu Ala Gly Val Thr Thr Asn Pro Ser Ile Ile  
 20 25 30

gcc gcg ggt aaa aaa ccg ctg gat gtt gtg ctt ccg caa ctt cat gaa 144  
 Ala Ala Gly Lys Lys Pro Leu Asp Val Val Leu Pro Gln Leu His Glu  
 35 40 45



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gcg atg ggc ggt cag ggg cgt ctg ttt gcc cag gta atg gct acc act 192
Ala Met Gly Gly Gln Gly Arg Leu Phe Ala Gln Val Met Ala Thr Thr
   50                               55                               60

gcc gaa ggg atg gtt aat gac gcg ctt aag ctg cgt tct att att gcg 240
Ala Glu Gly Met Val Asn Asp Ala Leu Lys Leu Arg Ser Ile Ile Ala
   65                               70                               75                               80

gat atc gtg gtg aaa gtt ccg gtg acc gcc gag ggg ctg gca gct att 288
Asp Ile Val Val Lys Val Pro Val Thr Ala Glu Gly Leu Ala Ala Ile
   85                               90                               95

aag atg tta aaa gcg gaa ggg att ccg acg ctg gga acc gcg gta tat 336
Lys Met Leu Lys Ala Glu Gly Ile Pro Thr Leu Gly Thr Ala Val Tyr
   100                               105                               110

ggc gca gca caa ggg ctg ctg tcg gcg ctg gca ggt gcg gaa tat gtt 384
Gly Ala Ala Gln Gly Leu Leu Ser Ala Leu Ala Gly Ala Glu Tyr Val
   115                               120                               125

gcg cct tac gtt aat cgt att gat gct cag gcc ggt agc gcc att cag 432
Ala Pro Tyr Val Asn Arg Ile Asp Ala Gln Gly Gly Ser Gly Ile Gln
   130                               135                               140

act gtg acc gac tta cac cag tta ttg aaa atg cat gcg ccg cag gcg 480
Thr Val Thr Asp Leu His Gln Leu Leu Lys Met His Ala Pro Gln Ala
   145                               150                               155                               160

aaa gtg ctg gca gcg agt ttc aaa acc ccg cgt cag gcg ctg gac tgc 528
Lys Val Leu Ala Ala Ser Phe Lys Thr Pro Arg Gln Ala Leu Asp Cys
   165                               170                               175

tta ctg gca gga tgt gaa tca att act ctg cca ctg gat gtg gca caa 576
Leu Leu Ala Gly Cys Glu Ser Ile Thr Leu Pro Leu Asp Val Ala Gln
   180                               185                               190

cag atg att agc tat ccg gcg gtt gat gcc gct gtg gcg aag ttt gag 624
Gln Met Ile Ser Tyr Pro Ala Val Asp Ala Ala Val Ala Lys Phe Glu
   195                               200                               205

cag gac tgg cag gga gcg ttt ggc aga acg tcg att taa 663
Gln Asp Trp Gln Gly Ala Phe Gly Arg Thr Ser Ile
   210                               215                               220

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&lt;210&gt; SEQ ID NO 69

&lt;211&gt; LENGTH: 220

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Escherichia coli

&lt;400&gt; SEQUENCE: 69

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Met Glu Leu Tyr Leu Asp Thr Ser Asp Val Val Ala Val Lys Ala Leu
1                               5                               10                               15

Ser Arg Ile Phe Pro Leu Ala Gly Val Thr Thr Asn Pro Ser Ile Ile
20                               25                               30

Ala Ala Gly Lys Lys Pro Leu Asp Val Val Leu Pro Gln Leu His Glu
35                               40                               45

Ala Met Gly Gly Gln Gly Arg Leu Phe Ala Gln Val Met Ala Thr Thr
50                               55                               60

Ala Glu Gly Met Val Asn Asp Ala Leu Lys Leu Arg Ser Ile Ile Ala
65                               70                               75                               80

Asp Ile Val Val Lys Val Pro Val Thr Ala Glu Gly Leu Ala Ala Ile
85                               90                               95

Lys Met Leu Lys Ala Glu Gly Ile Pro Thr Leu Gly Thr Ala Val Tyr
100                               105                               110

Gly Ala Ala Gln Gly Leu Leu Ser Ala Leu Ala Gly Ala Glu Tyr Val
115                               120                               125

Ala Pro Tyr Val Asn Arg Ile Asp Ala Gln Gly Gly Ser Gly Ile Gln
130                               135                               140

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Thr Val Thr Asp Leu His Gln Leu Leu Lys Met His Ala Pro Gln Ala  
 145 150 155 160  
 Lys Val Leu Ala Ala Ser Phe Lys Thr Pro Arg Gln Ala Leu Asp Cys  
 165 170 175  
 Leu Leu Ala Gly Cys Glu Ser Ile Thr Leu Pro Leu Asp Val Ala Gln  
 180 185 190  
 Gln Met Ile Ser Tyr Pro Ala Val Asp Ala Ala Val Ala Lys Phe Glu  
 195 200 205  
 Gln Asp Trp Gln Gly Ala Phe Gly Arg Thr Ser Ile  
 210 215 220

<210> SEQ ID NO 70  
 <211> LENGTH: 663  
 <212> TYPE: DNA  
 <213> ORGANISM: Escherichia coli  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(663)

<400> SEQUENCE: 70

atg gaa ctg tat ctg gac acc gct aac gtc gca gaa gtc gaa cgt ctg 48  
 Met Glu Leu Tyr Leu Asp Thr Ala Asn Val Ala Glu Val Glu Arg Leu  
 1 5 10 15  
 gca cgc ata ttc ccc att gcc ggg gtg aca act aac ccg agc att atc 96  
 Ala Arg Ile Phe Pro Ile Ala Gly Val Thr Thr Asn Pro Ser Ile Ile  
 20 25 30  
 gct gcc agc aag gag tcc ata tgg gaa gtg ctg ccg cgt ctg caa aaa 144  
 Ala Ala Ser Lys Glu Ser Ile Trp Glu Val Leu Pro Arg Leu Gln Lys  
 35 40 45  
 gcg att ggt gat gag ggc att ctg ttt gct cag acc atg agc cgc gac 192  
 Ala Ile Gly Asp Glu Gly Ile Leu Phe Ala Gln Thr Met Ser Arg Asp  
 50 55 60  
 gcg cag ggg atg gtg gaa gaa gcg aag cgc ctg cgc gac gct att ccg 240  
 Ala Gln Gly Met Val Glu Glu Ala Lys Arg Leu Arg Asp Ala Ile Pro  
 65 70 75 80  
 ggt att gtg gtg aaa atc ccg gtg act tcc gaa ggt ctg gca gca att 288  
 Gly Ile Val Val Lys Ile Pro Val Thr Ser Glu Gly Leu Ala Ala Ile  
 85 90 95  
 aaa ata ctg aaa aaa gag ggt att act aca ctt ggc act gct gta tat 336  
 Lys Ile Leu Lys Lys Glu Gly Ile Thr Thr Leu Gly Thr Ala Val Tyr  
 100 105 110  
 agc gcc gca caa ggg tta tta gcc gca ctg gca ggg gca aaa tac gtt 384  
 Ser Ala Ala Gln Gly Leu Leu Ala Ala Leu Ala Gly Ala Lys Tyr Val  
 115 120 125  
 gct ccg tat gtt aac cgc gta gat gcc cag ggc gga gac ggc att cgt 432  
 Ala Pro Tyr Val Asn Arg Val Asp Ala Gln Gly Gly Asp Gly Ile Arg  
 130 135 140  
 acg gtt cag gag ctg caa acg ctg tta gaa atg cac gcg cca gaa agc 480  
 Thr Val Gln Glu Leu Gln Thr Leu Leu Glu Met His Ala Pro Glu Ser  
 145 150 155 160  
 atg gtg ctg gca gcc agc ttt aaa acg ccg cgt cag gcg ctg gac tgt 528  
 Met Val Leu Ala Ala Ser Phe Lys Thr Pro Arg Gln Ala Leu Asp Cys  
 165 170 175  
 tta ctg gca gga tgt gaa tcc atc acc ctg ccc tta gat gta gcg caa 576  
 Leu Leu Ala Gly Cys Glu Ser Ile Thr Leu Pro Leu Asp Val Ala Gln  
 180 185 190  
 caa atg ctc aac acc cct gcg gta gag tca gct ata gag aag ttc gaa 624  
 Gln Met Leu Asn Thr Pro Ala Val Glu Ser Ala Ile Glu Lys Phe Glu  
 195 200 205  
 cac gac tgg aat gcc gca ttt ggc act act cat ctc taa 663  
 His Asp Trp Asn Ala Ala Phe Gly Thr Thr His Leu



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210                      215                      220

<210> SEQ ID NO 71  
 <211> LENGTH: 220  
 <212> TYPE: PRT  
 <213> ORGANISM: Escherichia coli

<400> SEQUENCE: 71

Met Glu Leu Tyr Leu Asp Thr Ala Asn Val Ala Glu Val Glu Arg Leu  
 1                      5                      10                      15

Ala Arg Ile Phe Pro Ile Ala Gly Val Thr Thr Asn Pro Ser Ile Ile  
                     20                      25                      30

Ala Ala Ser Lys Glu Ser Ile Trp Glu Val Leu Pro Arg Leu Gln Lys  
                     35                      40                      45

Ala Ile Gly Asp Glu Gly Ile Leu Phe Ala Gln Thr Met Ser Arg Asp  
                     50                      55                      60

Ala Gln Gly Met Val Glu Glu Ala Lys Arg Leu Arg Asp Ala Ile Pro  
                     65                      70                      75                      80

Gly Ile Val Val Lys Ile Pro Val Thr Ser Glu Gly Leu Ala Ala Ile  
                     85                      90                      95

Lys Ile Leu Lys Lys Glu Gly Ile Thr Thr Leu Gly Thr Ala Val Tyr  
                     100                      105                      110

Ser Ala Ala Gln Gly Leu Leu Ala Ala Leu Ala Gly Ala Lys Tyr Val  
                     115                      120                      125

Ala Pro Tyr Val Asn Arg Val Asp Ala Gln Gly Gly Asp Gly Ile Arg  
                     130                      135                      140

Thr Val Gln Glu Leu Gln Thr Leu Leu Glu Met His Ala Pro Glu Ser  
                     145                      150                      155                      160

Met Val Leu Ala Ala Ser Phe Lys Thr Pro Arg Gln Ala Leu Asp Cys  
                     165                      170                      175

Leu Leu Ala Gly Cys Glu Ser Ile Thr Leu Pro Leu Asp Val Ala Gln  
                     180                      185                      190

Gln Met Leu Asn Thr Pro Ala Val Glu Ser Ala Ile Glu Lys Phe Glu  
                     195                      200                      205

His Asp Trp Asn Ala Ala Phe Gly Thr Thr His Leu  
                     210                      215                      220

<210> SEQ ID NO 72  
 <211> LENGTH: 1053  
 <212> TYPE: DNA  
 <213> ORGANISM: Escherichia coli  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1053)

<400> SEQUENCE: 72

atg aca gat att gcg cag ttg ctt ggc aaa gac gcc gac aac ctt tta                      48  
 Met Thr Asp Ile Ala Gln Leu Leu Gly Lys Asp Ala Asp Asn Leu Leu  
 1                      5                      10                      15

cag cac cgt tgt atg aca att cct tct gac cag ctt tat ctc ccc gga                      96  
 Gln His Arg Cys Met Thr Ile Pro Ser Asp Gln Leu Tyr Leu Pro Gly  
                     20                      25                      30

cat gac tac gta gac cgc gta atg att gac aat aat cgc ccg cca gcg                      144  
 His Asp Tyr Val Asp Arg Val Met Ile Asp Asn Asn Arg Pro Pro Ala  
                     35                      40                      45

gtg tta cgt aat atg cag acg ttg tac aac acc ggg cgt ctg gct ggc                      192  
 Val Leu Arg Asn Met Gln Thr Leu Tyr Asn Thr Gly Arg Leu Ala Gly  
                     50                      55                      60

aca gga tat ctt tct att ctg ccg gtt gac cag ggc gtt gag cac tct                      240

-continued

Thr	Gly	Tyr	Leu	Ser	Ile	Leu	Pro	Val	Asp	Gln	Gly	Val	Glu	His	Ser		
65					70					75					80		
gcc	gga	gct	tca	ttt	gct	gct	aac	ccg	ctc	tac	ttt	gac	ccg	aaa	aac	288	
Ala	Gly	Ala	Ser	Phe	Ala	Ala	Asn	Pro	Leu	Tyr	Phe	Asp	Pro	Lys	Asn		
			85						90					95			
att	ggt	gaa	ctg	gcg	atc	gaa	gcg	ggc	tgt	aac	tgt	gtg	gcg	tca	act	336	
Ile	Val	Glu	Leu	Ala	Ile	Glu	Ala	Gly	Cys	Asn	Cys	Val	Ala	Ser	Thr		
			100					105					110				
tac	ggc	gtg	ctg	gcg	tcg	gta	tcg	ccg	cgt	tat	gcg	cat	cgc	att	cca	384	
Tyr	Gly	Val	Leu	Ala	Ser	Val	Ser	Arg	Arg	Tyr	Ala	His	Arg	Ile	Pro		
			115				120						125				
ttc	ctc	gtc	aaa	ctt	aat	cac	aac	gag	acg	cta	agt	tac	ccg	aat	acc	432	
Phe	Leu	Val	Lys	Leu	Asn	His	Asn	Glu	Thr	Leu	Ser	Tyr	Pro	Asn	Thr		
			130				135					140					
tac	gat	caa	acg	ctg	tat	gcc	agc	gtg	gag	cag	gcg	ttc	aac	atg	ggc	480	
Tyr	Asp	Gln	Thr	Leu	Tyr	Ala	Ser	Val	Glu	Gln	Ala	Phe	Asn	Met	Gly		
						150				155					160		
gcg	ggt	gcg	ggt	ggt	gcg	act	atc	tat	ttt	ggc	tcg	gaa	gag	tca	cgt	528	
Ala	Val	Ala	Val	Gly	Ala	Thr	Ile	Tyr	Phe	Gly	Ser	Glu	Glu	Ser	Arg		
				165					170					175			
cgc	cag	att	gaa	gaa	att	tct	gcg	gct	ttt	gaa	cgt	gcg	cac	gag	ctg	576	
Arg	Gln	Ile	Glu	Glu	Ile	Ser	Ala	Ala	Phe	Glu	Arg	Ala	His	Glu	Leu		
			180					185					190				
ggt	atg	gtg	aca	gtg	ctg	tgg	gcc	tat	ttg	cgt	aac	tcc	gcc	ttt	aag	624	
Gly	Met	Val	Thr	Val	Leu	Trp	Ala	Tyr	Leu	Arg	Asn	Ser	Ala	Phe	Lys		
			195				200					205					
aaa	gat	ggc	ggt	gat	tac	cat	ggt	tcc	gcc	gac	ctg	acc	ggt	cag	gca	672	
Lys	Asp	Gly	Val	Asp	Tyr	His	Val	Ser	Ala	Asp	Leu	Thr	Gly	Gln	Ala		
			210				215				220						
aac	cat	ctg	gcg	gca	acc	atc	ggt	gca	gat	atc	gtc	aaa	caa	aaa	atg	720	
Asn	His	Leu	Ala	Ala	Thr	Ile	Gly	Ala	Asp	Ile	Val	Lys	Gln	Lys	Met		
					225		230			235					240		
gcg	gaa	aat	aac	ggc	ggc	tat	aaa	gca	att	aat	tac	ggt	tac	acc	gac	768	
Ala	Glu	Asn	Asn	Gly	Gly	Tyr	Lys	Ala	Ile	Asn	Tyr	Gly	Tyr	Thr	Asp		
				245					250					255			
gat	cgt	ggt	tac	agc	aaa	ttg	acc	agc	gaa	aac	ccg	att	gat	ctg	gtg	816	
Asp	Arg	Val	Tyr	Ser	Lys	Leu	Thr	Ser	Glu	Asn	Pro	Ile	Asp	Leu	Val		
			260					265					270				
cgt	tat	cag	tta	gct	aac	tgc	tat	atg	ggt	cgg	gct	ggg	ttg	ata	aac	864	
Arg	Tyr	Gln	Leu	Ala	Asn	Cys	Tyr	Met	Gly	Arg	Ala	Gly	Leu	Ile	Asn		
			275				280					285					
tcc	ggc	ggt	gct	gcg	ggc	ggt	gaa	act	gac	ctc	agc	gat	gca	gtg	cgt	912	
Ser	Gly	Gly	Ala	Ala	Gly	Gly	Glu	Thr	Asp	Leu	Ser	Asp	Ala	Val	Arg		
			290			295					300						
act	gcg	ggt	atc	aac	aaa	cgc	gca	ggc	gga	atg	ggg	ctg	att	ctt	gga	960	
Thr	Ala	Val	Ile	Asn	Lys	Arg	Ala	Gly	Gly	Met	Gly	Leu	Ile	Leu	Gly		
					305		310			315				320			
cgt	aaa	gcg	ttc	aag	aaa	tcg	atg	gct	gac	ggc	gtg	aaa	ctg	att	aac	1008	
Arg	Lys	Ala	Phe	Lys	Lys	Ser	Met	Ala	Asp	Gly	Val	Lys	Leu	Ile	Asn		
				325				330					335				
gcc	gtg	cag	gac	ggt	tat	ctc	gat	agc	aaa	att	act	atc	gcc	tga		1053	
Ala	Val	Gln	Asp	Val	Tyr	Leu	Asp	Ser	Lys	Ile	Thr	Ile	Ala				
				340				345					350				

&lt;210&gt; SEQ ID NO 73

&lt;211&gt; LENGTH: 350

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Escherichia coli

&lt;400&gt; SEQUENCE: 73

Met Thr Asp Ile Ala Gln Leu Leu Gly Lys Asp Ala Asp Asn Leu Leu

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1	5	10	15
Gln His Arg Cys Met Thr Ile Pro Ser Asp Gln Leu Tyr Leu Pro Gly	20	25	30
His Asp Tyr Val Asp Arg Val Met Ile Asp Asn Asn Arg Pro Pro Ala	35	40	45
Val Leu Arg Asn Met Gln Thr Leu Tyr Asn Thr Gly Arg Leu Ala Gly	50	55	60
Thr Gly Tyr Leu Ser Ile Leu Pro Val Asp Gln Gly Val Glu His Ser	65	70	75
Ala Gly Ala Ser Phe Ala Ala Asn Pro Leu Tyr Phe Asp Pro Lys Asn	85	90	95
Ile Val Glu Leu Ala Ile Glu Ala Gly Cys Asn Cys Val Ala Ser Thr	100	105	110
Tyr Gly Val Leu Ala Ser Val Ser Arg Arg Tyr Ala His Arg Ile Pro	115	120	125
Phe Leu Val Lys Leu Asn His Asn Glu Thr Leu Ser Tyr Pro Asn Thr	130	135	140
Tyr Asp Gln Thr Leu Tyr Ala Ser Val Glu Gln Ala Phe Asn Met Gly	145	150	155
Ala Val Ala Val Gly Ala Thr Ile Tyr Phe Gly Ser Glu Glu Ser Arg	165	170	175
Arg Gln Ile Glu Glu Ile Ser Ala Ala Phe Glu Arg Ala His Glu Leu	180	185	190
Gly Met Val Thr Val Leu Trp Ala Tyr Leu Arg Asn Ser Ala Phe Lys	195	200	205
Lys Asp Gly Val Asp Tyr His Val Ser Ala Asp Leu Thr Gly Gln Ala	210	215	220
Asn His Leu Ala Ala Thr Ile Gly Ala Asp Ile Val Lys Gln Lys Met	225	230	235
Ala Glu Asn Asn Gly Gly Tyr Lys Ala Ile Asn Tyr Gly Tyr Thr Asp	245	250	255
Asp Arg Val Tyr Ser Lys Leu Thr Ser Glu Asn Pro Ile Asp Leu Val	260	265	270
Arg Tyr Gln Leu Ala Asn Cys Tyr Met Gly Arg Ala Gly Leu Ile Asn	275	280	285
Ser Gly Gly Ala Ala Gly Gly Glu Thr Asp Leu Ser Asp Ala Val Arg	290	295	300
Thr Ala Val Ile Asn Lys Arg Ala Gly Gly Met Gly Leu Ile Leu Gly	305	310	315
Arg Lys Ala Phe Lys Lys Ser Met Ala Asp Gly Val Lys Leu Ile Asn	325	330	335
Ala Val Gln Asp Val Tyr Leu Asp Ser Lys Ile Thr Ile Ala	340	345	350

<210> SEQ ID NO 74  
 <211> LENGTH: 1143  
 <212> TYPE: DNA  
 <213> ORGANISM: Shigella dysenteriae  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1143)

<400> SEQUENCE: 74

atg ccg cat ttg gca cta ctc atc tct aaa gga gca att atg gac cgc	1	5	10	15
Met Pro His Leu Ala Leu Leu Ile Ser Lys Gly Ala Ile Met Asp Arg				



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att att caa tca ccg ggt aaa tac atc cag ggc gct gat gtg att aat	96
Ile Ile Gln Ser Pro Gly Lys Tyr Ile Gln Gly Ala Asp Val Ile Asn	
20 25 30	
cg t ctg ggc gaa tac ctg aag ccg ctg gca gaa ctc tgg tta gtg gtg	144
Arg Leu Gly Glu Tyr Leu Lys Pro Leu Ala Glu Leu Trp Leu Val Val	
35 40 45	
ggt gac aaa ttt gtt tta ggt ttt gct caa tcc act gtc gag aaa agc	192
Gly Asp Lys Phe Val Leu Gly Phe Ala Gln Ser Thr Val Glu Lys Ser	
50 55 60	
ttt aaa gat gct gga ctg gta gta gaa att gcg ccg ttt ggc ggt gaa	240
Phe Lys Asp Ala Gly Leu Val Val Glu Ile Ala Pro Phe Gly Gly Glu	
65 70 75 80	
tgt tcg caa aat gag atc gac cgt ctg cgt ggc atc gcg gag act gcg	288
Cys Ser Gln Asn Glu Ile Asp Arg Leu Arg Gly Ile Ala Glu Thr Ala	
85 90 95	
cag tgt ggc gca att ctc ggt atc ggt ggc gga aaa act ttc gat act	336
Gln Cys Gly Ala Ile Leu Gly Ile Gly Gly Gly Lys Thr Phe Asp Thr	
100 105 110	
gcc aaa gca ctg gca cat ttc atg ggt gtt ccg gta gcg atc gca ccg	384
Ala Lys Ala Leu Ala His Phe Met Gly Val Pro Val Ala Ile Ala Pro	
115 120 125	
acg atc gcc tct acc gac gca ccg tgc agc gca ttg tct gtt atc tac	432
Thr Ile Ala Ser Thr Asp Ala Pro Cys Ser Ala Leu Ser Val Ile Tyr	
130 135 140	
acc gat gag ggt gag ttt gac cgc tat ctg ctg ttg cca aat aac cct	480
Thr Asp Glu Gly Glu Phe Asp Arg Tyr Leu Leu Leu Pro Asn Asn Pro	
145 150 155 160	
aat atg gtc att gtc gac acc aaa atc gtc gct ggc gca cct gca cgt	528
Asn Met Val Ile Val Asp Thr Lys Ile Val Ala Gly Ala Pro Ala Arg	
165 170 175	
ctg tta gcg gcg ggt atc ggc gat gcg ctg gca acc tgg ttt gaa gcg	576
Leu Leu Ala Ala Gly Ile Gly Asp Ala Leu Ala Thr Trp Phe Glu Ala	
180 185 190	
cg t gcc tgc tct cgt agc ggc gcg acc acc atg gcg ggc ggc aag tgc	624
Arg Ala Cys Ser Arg Ser Gly Ala Thr Thr Met Ala Gly Gly Lys Cys	
195 200 205	
acc cag gct gcg ctg gca ctg gct gaa ctg tgc tac aac acc ctg ctg	672
Thr Gln Ala Ala Leu Ala Leu Ala Glu Leu Cys Tyr Asn Thr Leu Leu	
210 215 220	
gaa gaa ggc gaa aaa gcg atg ctt gct gcc gaa cag cat gta gtg act	720
Glu Glu Gly Glu Lys Ala Met Leu Ala Ala Glu Gln His Val Val Thr	
225 230 235 240	
ccg gcg ctg gag cgc gtg att gaa gcg aac acc tat ttg agc ggt gtt	768
Pro Ala Leu Glu Arg Val Ile Glu Ala Asn Thr Tyr Leu Ser Gly Val	
245 250 255	
ggt ttt gaa agt ggt ggt ctg gct gcg gcg cac gca gtg cat aac ggc	816
Gly Phe Glu Ser Gly Gly Leu Ala Ala Ala His Ala Val His Asn Gly	
260 265 270	
ctg acc gct atc ccg gac gcg cat cac tat tat cac ggt gaa aaa gtg	864
Leu Thr Ala Ile Pro Asp Ala His His Tyr Tyr His Gly Glu Lys Val	
275 280 285	
gca ttc ggt acg ctg acg cag ctg gtt ctg gaa aat gcg ccg gtg gag	912
Ala Phe Gly Thr Leu Thr Gln Leu Val Leu Glu Asn Ala Pro Val Glu	
290 295 300	
gaa atc gaa acc gta gct gcc ctt agc cat gcg gta ggt ttg cca ata	960
Glu Ile Glu Thr Val Ala Ala Leu Ser His Ala Val Gly Leu Pro Ile	
305 310 315 320	
act ctc gct caa ctg gat att aaa gaa gat gtc ccg gcg aaa atg cga	1008
Thr Leu Ala Gln Leu Asp Ile Lys Glu Asp Val Pro Ala Lys Met Arg	
325 330 335	

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att gtg gca gaa gcg gca tgt gca gaa ggt gaa acc att cac aac atg	1056
Ile Val Ala Glu Ala Ala Cys Ala Glu Gly Glu Thr Ile His Asn Met	
340 345 350	
cct ggc ggc gcg acg cca gat cag gtt tac gcc gca ctg ctg gta gct	1104
Pro Gly Gly Ala Thr Pro Asp Gln Val Tyr Ala Ala Leu Leu Val Ala	
355 360 365	
gac cag tat gga caa cgt ttc ctg caa gag tgg gaa taa	1143
Asp Gln Tyr Gly Gln Arg Phe Leu Gln Glu Trp Glu	
370 375 380	

&lt;210&gt; SEQ ID NO 75

&lt;211&gt; LENGTH: 380

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Shigella dysenteriae

&lt;400&gt; SEQUENCE: 75

Met Pro His Leu Ala Leu Leu Ile Ser Lys Gly Ala Ile Met Asp Arg	
1 5 10 15	
Ile Ile Gln Ser Pro Gly Lys Tyr Ile Gln Gly Ala Asp Val Ile Asn	
20 25 30	
Arg Leu Gly Glu Tyr Leu Lys Pro Leu Ala Glu Leu Trp Leu Val Val	
35 40 45	
Gly Asp Lys Phe Val Leu Gly Phe Ala Gln Ser Thr Val Glu Lys Ser	
50 55 60	
Phe Lys Asp Ala Gly Leu Val Val Glu Ile Ala Pro Phe Gly Gly Glu	
65 70 75 80	
Cys Ser Gln Asn Glu Ile Asp Arg Leu Arg Gly Ile Ala Glu Thr Ala	
85 90 95	
Gln Cys Gly Ala Ile Leu Gly Ile Gly Gly Gly Lys Thr Phe Asp Thr	
100 105 110	
Ala Lys Ala Leu Ala His Phe Met Gly Val Pro Val Ala Ile Ala Pro	
115 120 125	
Thr Ile Ala Ser Thr Asp Ala Pro Cys Ser Ala Leu Ser Val Ile Tyr	
130 135 140	
Thr Asp Glu Gly Glu Phe Asp Arg Tyr Leu Leu Leu Pro Asn Asn Pro	
145 150 155 160	
Asn Met Val Ile Val Asp Thr Lys Ile Val Ala Gly Ala Pro Ala Arg	
165 170 175	
Leu Leu Ala Ala Gly Ile Gly Asp Ala Leu Ala Thr Trp Phe Glu Ala	
180 185 190	
Arg Ala Cys Ser Arg Ser Gly Ala Thr Thr Met Ala Gly Gly Lys Cys	
195 200 205	
Thr Gln Ala Ala Leu Ala Leu Ala Glu Leu Cys Tyr Asn Thr Leu Leu	
210 215 220	
Glu Glu Gly Glu Lys Ala Met Leu Ala Ala Glu Gln His Val Val Thr	
225 230 235 240	
Pro Ala Leu Glu Arg Val Ile Glu Ala Asn Thr Tyr Leu Ser Gly Val	
245 250 255	
Gly Phe Glu Ser Gly Gly Leu Ala Ala Ala His Ala Val His Asn Gly	
260 265 270	
Leu Thr Ala Ile Pro Asp Ala His His Tyr Tyr His Gly Glu Lys Val	
275 280 285	
Ala Phe Gly Thr Leu Thr Gln Leu Val Leu Glu Asn Ala Pro Val Glu	
290 295 300	
Glu Ile Glu Thr Val Ala Ala Leu Ser His Ala Val Gly Leu Pro Ile	
305 310 315 320	

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Thr Leu Ala Gln Leu Asp Ile Lys Glu Asp Val Pro Ala Lys Met Arg  
 325 330 335

Ile Val Ala Glu Ala Ala Cys Ala Glu Gly Glu Thr Ile His Asn Met  
 340 345 350

Pro Gly Gly Ala Thr Pro Asp Gln Val Tyr Ala Ala Leu Leu Val Ala  
 355 360 365

Asp Gln Tyr Gly Gln Arg Phe Leu Gln Glu Trp Glu  
 370 375 380

<210> SEQ ID NO 76  
 <211> LENGTH: 1104  
 <212> TYPE: DNA  
 <213> ORGANISM: Salmonella typhimurium  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1104)

<400> SEQUENCE: 76

atg gat cgc att att cag tca cca ggt aag tat att cag ggt gca aac 48  
 Met Asp Arg Ile Ile Gln Ser Pro Gly Lys Tyr Ile Gln Gly Ala Asn  
 1 5 10 15

gtc atc gcg cgt ctt ggc gat tat tta aaa cca atg gcg aac aac tgg 96  
 Val Ile Ala Arg Leu Gly Asp Tyr Leu Lys Pro Met Ala Asn Asn Trp  
 20 25 30

ctg gtt gtg ggc gat aaa ttc gtg ctg gga ttt gcc gaa gag acg ctg 144  
 Leu Val Val Gly Asp Lys Phe Val Leu Gly Phe Ala Glu Glu Thr Leu  
 35 40 45

cgc aaa agc ctg acg gat gcc ggt ttg tca gta gaa atc gcc ccg ttt 192  
 Arg Lys Ser Leu Thr Asp Ala Gly Leu Ser Val Glu Ile Ala Pro Phe  
 50 55 60

ggc ggc gaa tgt tcg caa aat gag atc gac agg ctg cgc gcc gtc gcc 240  
 Gly Gly Glu Cys Ser Gln Asn Glu Ile Asp Arg Leu Arg Ala Val Ala  
 65 70 75 80

gaa aaa agt cag tgt ggc gcc gta ctg ggt atc ggc ggc ggt aaa acg 288  
 Glu Lys Ser Gln Cys Gly Ala Val Leu Gly Ile Gly Gly Gly Lys Thr  
 85 90 95

ctg gat acc gcc aaa gcg ctg gcg cac ttt atg aac gtc ccg gtc gct 336  
 Leu Asp Thr Ala Lys Ala Leu Ala His Phe Met Asn Val Pro Val Ala  
 100 105 110

atc gcg ccg acc atc gcc tct acc gac gca ccg tgc agc gca ctc tcg 384  
 Ile Ala Pro Thr Ile Ala Ser Thr Asp Ala Pro Cys Ser Ala Leu Ser  
 115 120 125

gtt att tat acc gat gcc ggt gag ttt gac cgt tat ctg ctg ctg ccg 432  
 Val Ile Tyr Thr Asp Ala Gly Glu Phe Asp Arg Tyr Leu Leu Leu Pro  
 130 135 140

cat aac ccg aat atg gtt att gtc gat acg cag ata gtg gcg ggc gcg 480  
 His Asn Pro Asn Met Val Ile Val Asp Thr Gln Ile Val Ala Gly Ala  
 145 150 155 160

ccg gcg cgt ctg ctg gca gcc ggt atc ggc gat gca ctg gcg acc tgg 528  
 Pro Ala Arg Leu Leu Ala Ala Gly Ile Gly Asp Ala Leu Ala Thr Trp  
 165 170 175

ttt gaa gcg cgc gcc tgc tca cgc agc ggc gcc acc aca atg gcg ggc 576  
 Phe Glu Ala Arg Ala Cys Ser Arg Ser Gly Ala Thr Thr Met Ala Gly  
 180 185 190

ggc aag tgt aca cag gcc gcg ctg gcg ctg gcg gag cta tgc tat aac 624  
 Gly Lys Cys Thr Gln Ala Ala Leu Ala Leu Ala Glu Leu Cys Tyr Asn  
 195 200 205

acg ctg atc gaa gaa ggc gaa aaa gcc atg ttg gcc gcc gaa cag cac 672  
 Thr Leu Ile Glu Glu Gly Glu Lys Ala Met Leu Ala Ala Glu Gln His  
 210 215 220

gtc gtc acg cca gcg ctg gaa cgc gtc atc gaa gcc aac acc tac ctg 720



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Val	Val	Thr	Pro	Ala	Leu	Glu	Arg	Val	Ile	Glu	Ala	Asn	Thr	Tyr	Leu	
225					230					235					240	
agc	ggg	gtc	ggt	ttt	gaa	agc	ggc	ggt	ctg	gcc	gca	gcg	cac	gcg	att	768
Ser	Gly	Val	Gly	Phe	Glu	Ser	Gly	Gly	Leu	Ala	Ala	Ala	His	Ala	Ile	
				245					250					255		
cat	aac	ggt	tta	acg	gcg	att	ccg	gat	gcg	cac	cac	tat	tat	cac	ggt	816
His	Asn	Gly	Leu	Thr	Ala	Ile	Pro	Asp	Ala	His	His	Tyr	Tyr	His	Gly	
			260					265					270			
gag	aag	gtc	gct	ttc	ggt	acg	ctg	acg	caa	ctg	gtg	ctg	gaa	aac	gcg	864
Glu	Lys	Val	Ala	Phe	Gly	Thr	Leu	Thr	Gln	Leu	Val	Leu	Glu	Asn	Ala	
		275					280					285				
ccg	gtc	gaa	gaa	atc	gaa	acc	ggt	gcg	gcg	ctg	tgc	cat	tcc	ggt	ggc	912
Pro	Val	Glu	Glu	Ile	Glu	Thr	Val	Ala	Ala	Leu	Cys	His	Ser	Val	Gly	
		290				295					300					
ctg	ccg	att	acg	ctg	gcg	caa	ctg	gat	att	aaa	cag	gat	att	ccg	gcc	960
Leu	Pro	Ile	Thr	Leu	Ala	Gln	Leu	Asp	Ile	Lys	Gln	Asp	Ile	Pro	Ala	
305					310					315					320	
aag	atg	cgc	acc	gtc	gcg	gaa	gcc	tcc	tgc	gca	gaa	ggt	gaa	act	att	1008
Lys	Met	Arg	Thr	Val	Ala	Glu	Ala	Ser	Cys	Ala	Glu	Gly	Glu	Thr	Ile	
				325					330					335		
cat	aac	atg	cct	ggc	ggc	gca	acg	ccg	gat	gaa	gtg	tac	gcc	gcg	ctg	1056
His	Asn	Met	Pro	Gly	Gly	Ala	Thr	Pro	Asp	Glu	Val	Tyr	Ala	Ala	Leu	
			340					345					350			
ctg	gtc	gcc	gac	cag	tac	ggt	caa	cgc	ttc	ttg	cag	gaa	tgg	gaa	taa	1104
Leu	Val	Ala	Asp	Gln	Tyr	Gly	Gln	Arg	Phe	Leu	Gln	Glu	Trp	Glu		
		355					360					365				

&lt;210&gt; SEQ ID NO 77

&lt;211&gt; LENGTH: 367

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Salmonella typhimurium

&lt;400&gt; SEQUENCE: 77

Met	Asp	Arg	Ile	Ile	Gln	Ser	Pro	Gly	Lys	Tyr	Ile	Gln	Gly	Ala	Asn	
1				5					10					15		
Val	Ile	Ala	Arg	Leu	Gly	Asp	Tyr	Leu	Lys	Pro	Met	Ala	Asn	Asn	Trp	
			20					25					30			
Leu	Val	Val	Gly	Asp	Lys	Phe	Val	Leu	Gly	Phe	Ala	Glu	Glu	Thr	Leu	
		35				40						45				
Arg	Lys	Ser	Leu	Thr	Asp	Ala	Gly	Leu	Ser	Val	Glu	Ile	Ala	Pro	Phe	
	50					55					60					
Gly	Gly	Glu	Cys	Ser	Gln	Asn	Glu	Ile	Asp	Arg	Leu	Arg	Ala	Val	Ala	
65					70				75						80	
Glu	Lys	Ser	Gln	Cys	Gly	Ala	Val	Leu	Gly	Ile	Gly	Gly	Gly	Lys	Thr	
			85						90					95		
Leu	Asp	Thr	Ala	Lys	Ala	Leu	Ala	His	Phe	Met	Asn	Val	Pro	Val	Ala	
			100					105					110			
Ile	Ala	Pro	Thr	Ile	Ala	Ser	Thr	Asp	Ala	Pro	Cys	Ser	Ala	Leu	Ser	
		115					120					125				
Val	Ile	Tyr	Thr	Asp	Ala	Gly	Glu	Phe	Asp	Arg	Tyr	Leu	Leu	Leu	Pro	
		130				135					140					
His	Asn	Pro	Asn	Met	Val	Ile	Val	Asp	Thr	Gln	Ile	Val	Ala	Gly	Ala	
145					150					155					160	
Pro	Ala	Arg	Leu	Leu	Ala	Ala	Gly	Ile	Gly	Asp	Ala	Leu	Ala	Thr	Trp	
			165						170					175		
Phe	Glu	Ala	Arg	Ala	Cys	Ser	Arg	Ser	Gly	Ala	Thr	Thr	Met	Ala	Gly	
		180						185					190			
Gly	Lys	Cys	Thr	Gln	Ala	Ala	Leu	Ala	Leu	Ala	Glu	Leu	Cys	Tyr	Asn	

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195	200	205
Thr Leu Ile Glu Glu Gly Glu Lys Ala Met Leu Ala Ala Glu Gln His 210 215 220		
Val Val Thr Pro Ala Leu Glu Arg Val Ile Glu Ala Asn Thr Tyr Leu 225 230 235 240		
Ser Gly Val Gly Phe Glu Ser Gly Gly Leu Ala Ala Ala His Ala Ile 245 250 255		
His Asn Gly Leu Thr Ala Ile Pro Asp Ala His His Tyr Tyr His Gly 260 265 270		
Glu Lys Val Ala Phe Gly Thr Leu Thr Gln Leu Val Leu Glu Asn Ala 275 280 285		
Pro Val Glu Glu Ile Glu Thr Val Ala Ala Leu Cys His Ser Val Gly 290 295 300		
Leu Pro Ile Thr Leu Ala Gln Leu Asp Ile Lys Gln Asp Ile Pro Ala 305 310 315 320		
Lys Met Arg Thr Val Ala Glu Ala Ser Cys Ala Glu Gly Glu Thr Ile 325 330 335		
His Asn Met Pro Gly Gly Ala Thr Pro Asp Glu Val Tyr Ala Ala Leu 340 345 350		
Leu Val Ala Asp Gln Tyr Gly Gln Arg Phe Leu Gln Glu Trp Glu 355 360 365		

<210> SEQ ID NO 78  
 <211> LENGTH: 1098  
 <212> TYPE: DNA  
 <213> ORGANISM: Pseudomonas putida  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1098)

<400> SEQUENCE: 78

atg gac cgc gcc att caa tca ccc ggc aaa tat gta caa ggg gcc gat Met Asp Arg Ala Ile Gln Ser Pro Gly Lys Tyr Val Gln Gly Ala Asp 1 5 10 15	48
gcg ctg caa cgg ctg ggg gac tac ctc aag ccg ctg gcg gac agc tgg Ala Leu Gln Arg Leu Gly Asp Tyr Leu Lys Pro Leu Ala Asp Ser Trp 20 25 30	96
ctg gtg att gcc gac aag ttc gtg ctg ggc ttt gcc gaa gac acc atc Leu Val Ile Ala Asp Lys Phe Val Leu Gly Phe Ala Glu Asp Thr Ile 35 40 45	144
cgc caa agc ctc agc aag gcc ggg ctg gcc atg gac atc gtc gcc ttc Arg Gln Ser Leu Ser Lys Ala Gly Leu Ala Met Asp Ile Val Ala Phe 50 55 60	192
aac ggc gaa tgc tcg cag ggc gag gtc gat cgc ctg tgc caa ctg gcc Asn Gly Glu Cys Ser Gln Gly Glu Val Asp Arg Leu Cys Gln Leu Ala 65 70 75 80	240
acg caa aac ggg cgc agc gcc atc gtc ggc att ggt ggc ggc aag acg Thr Gln Asn Gly Arg Ser Ala Ile Val Gly Ile Gly Gly Gly Lys Thr 85 90 95	288
ctg gac acc gcc aag gcc gtg gcc ttt ttc cag aaa gtg ccc gtg gcc Leu Asp Thr Ala Lys Ala Val Ala Phe Phe Gln Lys Val Pro Val Ala 100 105 110	336
gtg gcc ccc acc atc gcc tcc acc gac gcg ccc tgc agc gcg ctg tcg Val Ala Pro Thr Ile Ala Ser Thr Asp Ala Pro Cys Ser Ala Leu Ser 115 120 125	384
gtg ctc tat acc gat gaa ggt gag ttc gac cgc tat ctg atg ctg ccc Val Leu Tyr Thr Asp Glu Gly Glu Phe Asp Arg Tyr Leu Met Leu Pro 130 135 140	432
acc aac ccc gcc ctg gtg gtg gtg gac acc gcc atc gtc gcc cgt gca	480

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Thr	Asn	Pro	Ala	Leu	Val	Val	Val	Asp	Thr	Ala	Ile	Val	Ala	Arg	Ala		
145					150					155					160		
ccg	gcg	cgg	ctg	ttg	gcg	gcc	ggc	att	ggt	gat	gcc	ctg	gcc	acc	tgg		528
Pro	Ala	Arg	Leu	Leu	Ala	Ala	Gly	Ile	Gly	Asp	Ala	Leu	Ala	Thr	Trp		
			165						170					175			
ttc	gag	gcg	cgt	gcc	gca	tcg	cgc	agc	agc	gct	gcc	acc	atg	gcc	ggc		576
Phe	Glu	Ala	Arg	Ala	Ala	Ser	Arg	Ser	Ser	Ala	Ala	Thr	Met	Ala	Gly		
			180					185					190				
ggc	ccg	gcc	acg	cag	acc	gca	ctg	aac	ctg	gcc	agg	ttc	tgc	tac	gac		624
Gly	Pro	Ala	Thr	Gln	Thr	Ala	Leu	Asn	Leu	Ala	Arg	Phe	Cys	Tyr	Asp		
		195					200					205					
acc	ctg	ctg	gaa	gag	ggt	gaa	aaa	gcc	atg	ttg	gcc	gtg	cag	gcc	cag		672
Thr	Leu	Leu	Glu	Glu	Gly	Glu	Lys	Ala	Met	Leu	Ala	Val	Gln	Ala	Gln		
	210					215				220							
gtg	gtg	acg	ccg	gcg	ctg	gag	cgc	atc	gtc	gag	gcc	aac	acc	tat	ctg		720
Val	Val	Thr	Pro	Ala	Leu	Glu	Arg	Ile	Val	Glu	Ala	Asn	Thr	Tyr	Leu		
225					230					235					240		
agc	ggg	gtc	ggg	ttt	gaa	agc	ggt	ggc	gtg	gcc	gcc	gcc	cac	gcg	gtg		768
Ser	Gly	Val	Gly	Phe	Glu	Ser	Gly	Gly	Val	Ala	Ala	Ala	His	Ala	Val		
			245						250					255			
cac	aac	ggc	ctg	acc	gcc	gtg	gcc	gaa	acc	cac	cac	ttc	tac	cac	ggc		816
His	Asn	Gly	Leu	Thr	Ala	Val	Ala	Glu	Thr	His	His	Phe	Tyr	His	Gly		
			260					265					270				
gaa	aaa	gtg	gcg	ttt	ggc	gtg	ctg	gtg	caa	ctg	gcg	ctg	gaa	aac	gcc		864
Glu	Lys	Val	Ala	Phe	Gly	Val	Leu	Val	Gln	Leu	Ala	Leu	Glu	Asn	Ala		
		275					280					285					
tcc	aac	gcg	gaa	atg	cag	gaa	gtg	atg	tcg	ctg	tgc	cac	gcc	gtg	ggc		912
Ser	Asn	Ala	Glu	Met	Gln	Glu	Val	Met	Ser	Leu	Cys	His	Ala	Val	Gly		
	290					295					300						
ctg	ccc	atc	acg	ctg	gcg	cag	ctg	gac	att	acc	gaa	gac	atc	ccc	acc		960
Leu	Pro	Ile	Thr	Leu	Ala	Gln	Leu	Asp	Ile	Thr	Glu	Asp	Ile	Pro	Thr		
305					310					315					320		
aag	atg	cgc	gcc	gtg	gcc	gag	ctg	gcc	tgc	gcc	cca	ggc	gag	acc	atc		1008
Lys	Met	Arg	Ala	Val	Ala	Glu	Leu	Ala	Cys	Ala	Pro	Gly	Glu	Thr	Ile		
				325					330					335			
cac	aac	atg	ccc	ggc	ggc	gtg	acg	gtg	gag	cag	gtc	tat	ggc	gcg	ctg		1056
His	Asn	Met	Pro	Gly	Gly	Val	Thr	Val	Glu	Gln	Val	Tyr	Gly	Ala	Leu		
			340					345					350				
ctg	gtg	gcg	gac	cag	ctg	ggg	cag	cat	ttt	ctg	gag	ttt	tga				1098
Leu	Val	Ala	Asp	Gln	Leu	Gly	Gln	His	Phe	Leu	Glu	Phe					
		355					360					365					

&lt;210&gt; SEQ ID NO 79

&lt;211&gt; LENGTH: 365

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Pseudomonas putida

&lt;400&gt; SEQUENCE: 79

Met	Asp	Arg	Ala	Ile	Gln	Ser	Pro	Gly	Lys	Tyr	Val	Gln	Gly	Ala	Asp		
1				5					10					15			
Ala	Leu	Gln	Arg	Leu	Gly	Asp	Tyr	Leu	Lys	Pro	Leu	Ala	Asp	Ser	Trp		
		20						25					30				
Leu	Val	Ile	Ala	Asp	Lys	Phe	Val	Leu	Gly	Phe	Ala	Glu	Asp	Thr	Ile		
		35					40					45					
Arg	Gln	Ser	Leu	Ser	Lys	Ala	Gly	Leu	Ala	Met	Asp	Ile	Val	Ala	Phe		
		50				55					60						
Asn	Gly	Glu	Cys	Ser	Gln	Gly	Glu	Val	Asp	Arg	Leu	Cys	Gln	Leu	Ala		
65					70				75					80			
Thr	Gln	Asn	Gly	Arg	Ser	Ala	Ile	Val	Gly	Ile	Gly	Gly	Gly	Lys	Thr		
			85						90					95			



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Leu Asp Thr Ala Lys Ala Val Ala Phe Phe Gln Lys Val Pro Val Ala  
 100 105 110  
 Val Ala Pro Thr Ile Ala Ser Thr Asp Ala Pro Cys Ser Ala Leu Ser  
 115 120 125  
 Val Leu Tyr Thr Asp Glu Gly Glu Phe Asp Arg Tyr Leu Met Leu Pro  
 130 135 140  
 Thr Asn Pro Ala Leu Val Val Val Asp Thr Ala Ile Val Ala Arg Ala  
 145 150 155 160  
 Pro Ala Arg Leu Leu Ala Ala Gly Ile Gly Asp Ala Leu Ala Thr Trp  
 165 170 175  
 Phe Glu Ala Arg Ala Ala Ser Arg Ser Ser Ala Ala Thr Met Ala Gly  
 180 185 190  
 Gly Pro Ala Thr Gln Thr Ala Leu Asn Leu Ala Arg Phe Cys Tyr Asp  
 195 200 205  
 Thr Leu Leu Glu Glu Gly Glu Lys Ala Met Leu Ala Val Gln Ala Gln  
 210 215 220  
 Val Val Thr Pro Ala Leu Glu Arg Ile Val Glu Ala Asn Thr Tyr Leu  
 225 230 235 240  
 Ser Gly Val Gly Phe Glu Ser Gly Gly Val Ala Ala Ala His Ala Val  
 245 250 255  
 His Asn Gly Leu Thr Ala Val Ala Glu Thr His His Phe Tyr His Gly  
 260 265 270  
 Glu Lys Val Ala Phe Gly Val Leu Val Gln Leu Ala Leu Glu Asn Ala  
 275 280 285  
 Ser Asn Ala Glu Met Gln Glu Val Met Ser Leu Cys His Ala Val Gly  
 290 295 300  
 Leu Pro Ile Thr Leu Ala Gln Leu Asp Ile Thr Glu Asp Ile Pro Thr  
 305 310 315 320  
 Lys Met Arg Ala Val Ala Glu Leu Ala Cys Ala Pro Gly Glu Thr Ile  
 325 330 335  
 His Asn Met Pro Gly Gly Val Thr Val Glu Gln Val Tyr Gly Ala Leu  
 340 345 350  
 Leu Val Ala Asp Gln Leu Gly Gln His Phe Leu Glu Phe  
 355 360 365

<210> SEQ ID NO 80  
 <211> LENGTH: 1104  
 <212> TYPE: DNA  
 <213> ORGANISM: Bacillus coagulans  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1104)

<400> SEQUENCE: 80

atg acg aaa atc att acc tct cca agc aag ttt ata caa ggc ccc gat 48  
 Met Thr Lys Ile Ile Thr Ser Pro Ser Lys Phe Ile Gln Gly Pro Asp  
 1 5 10 15  
 gaa ttg tcc agg ctt tcg gcg tat acg gaa agg ctt ggc aaa aaa gca 96  
 Glu Leu Ser Arg Leu Ser Ala Tyr Thr Glu Arg Leu Gly Lys Lys Ala  
 20 25 30  
 ttt att att gcg gat gat ttt gtc acc ggc ctt gtc ggc aaa acg gtt 144  
 Phe Ile Ile Ala Asp Asp Phe Val Thr Gly Leu Val Gly Lys Thr Val  
 35 40 45  
 gaa gaa agc tat gcc ggc aaa gaa acg ggg tat caa atg gca tta ttc 192  
 Glu Glu Ser Tyr Ala Gly Lys Glu Thr Gly Tyr Gln Met Ala Leu Phe  
 50 55 60  
 ggt ggt gag tgt tct aaa ccg gaa atc gaa cgg ctt tgt gaa atg agc 240

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Gly	Gly	Glu	Cys	Ser	Lys	Pro	Glu	Ile	Glu	Arg	Leu	Cys	Glu	Met	Ser	
65					70					75					80	
aaa	tcc	gag	gaa	gcc	gat	gtc	gtt	gtc	gga	atc	ggc	ggc	gga	aaa	aca	288
Lys	Ser	Glu	Glu	Ala	Asp	Val	Val	Val	Gly	Ile	Gly	Gly	Gly	Lys	Thr	
				85					90					95		
ttg	gat	acc	gca	aaa	gca	gtc	ggg	tat	tac	aat	aac	att	ccg	gtg	att	336
Leu	Asp	Thr	Ala	Lys	Ala	Val	Gly	Tyr	Tyr	Asn	Asn	Ile	Pro	Val	Ile	
			100					105					110			
gtc	gcg	ccg	acc	atc	gct	tcc	acc	gat	gcc	ccg	aca	agc	gcc	ctg	tct	384
Val	Ala	Pro	Thr	Ile	Ala	Ser	Thr	Asp	Ala	Pro	Thr	Ser	Ala	Leu	Ser	
		115					120					125				
gtt	att	tac	aaa	gag	aac	ggc	gag	ttt	gaa	gaa	tac	ttg	atg	ctg	ccg	432
Val	Ile	Tyr	Lys	Glu	Asn	Gly	Glu	Phe	Glu	Glu	Tyr	Leu	Met	Leu	Pro	
	130					135					140					
ctg	aac	ccg	act	ttt	gtc	att	atg	gat	acg	aaa	gtg	att	gcc	tct	gcc	480
Leu	Asn	Pro	Thr	Phe	Val	Ile	Met	Asp	Thr	Lys	Val	Ile	Ala	Ser	Ala	
	145				150					155					160	
cct	gcc	cgc	ctg	ctc	gtt	tcc	ggc	atg	gga	gat	gcg	ctt	gca	acg	tat	528
Pro	Ala	Arg	Leu	Leu	Val	Ser	Gly	Met	Gly	Asp	Ala	Leu	Ala	Thr	Tyr	
				165				170						175		
ttt	gaa	gcg	cgc	gcc	act	aag	cgg	gca	aat	aaa	acg	acg	atg	gca	ggc	576
Phe	Glu	Ala	Arg	Ala	Thr	Lys	Arg	Ala	Asn	Lys	Thr	Thr	Met	Ala	Gly	
			180					185					190			
ggg	cgT	gTt	acg	gaa	gcg	gcg	atc	gcg	ctt	gca	aaa	ctt	tgt	tat	gac	624
Gly	Arg	Val	Thr	Glu	Ala	Ala	Ile	Ala	Leu	Ala	Lys	Leu	Cys	Tyr	Asp	
		195					200					205				
acg	caa	att	tcg	gaa	ggt	tta	aaa	gca	aaa	ctg	gca	gcg	gaa	aaa	cat	672
Thr	Gln	Ile	Ser	Glu	Gly	Leu	Lys	Ala	Lys	Leu	Ala	Ala	Glu	Lys	His	
	210					215					220					
ctt	gTt	acg	gaa	gca	gtg	gaa	aaa	atc	att	gaa	gcg	aat	acg	tat	ctg	720
Leu	Val	Thr	Glu	Ala	Val	Glu	Lys	Ile	Ile	Glu	Ala	Asn	Thr	Tyr	Leu	
	225					230				235					240	
agc	gga	atc	ggt	ttt	gaa	agc	ggc	ggc	ctt	gct	gcg	gca	cat	gcg	atc	768
Ser	Gly	Ile	Gly	Phe	Glu	Ser	Gly	Gly	Leu	Ala	Ala	Ala	His	Ala	Ile	
				245					250					255		
cat	aat	ggg	ctt	acc	gtg	ctc	gaa	gaa	acc	cat	cat	atg	tac	cac	ggc	816
His	Asn	Gly	Leu	Thr	Val	Leu	Glu	Glu	Thr	His	His	Met	Tyr	His	Gly	
			260					265					270			
gaa	aaa	gtg	gca	ttc	ggt	acc	ctc	gcc	cag	ctg	att	ttg	gaa	gat	gcg	864
Glu	Lys	Val	Ala	Phe	Gly	Thr	Leu	Ala	Gln	Leu	Ile	Leu	Glu	Asp	Ala	
		275					280					285				
ccg	aaa	gcg	gaa	att	gaa	gag	gtg	gtc	tcc	ttc	tgc	ctg	agt	gtc	gga	912
Pro	Lys	Ala	Glu	Ile	Glu	Glu	Val	Val	Ser	Phe	Cys	Leu	Ser	Val	Gly	
	290					295					300					
ctt	ccc	gtc	acg	ctc	ggg	gat	ttg	ggc	gtg	aaa	gaa	ctg	aat	gag	gaa	960
Leu	Pro	Val	Thr	Leu	Gly	Asp	Leu	Gly	Val	Lys	Glu	Leu	Asn	Glu	Glu	
	305				310					315				320		
aag	ctc	cga	aaa	gtg	gct	gaa	ctt	tcc	tgt	gcg	gaa	ggc	gaa	acg	att	1008
Lys	Leu	Arg	Lys	Val	Ala	Glu	Leu	Ser	Cys	Ala	Glu	Gly	Glu	Thr	Ile	
			325					330					335			
tat	aac	atg	ccg	ttt	gaa	gtc	acg	cct	gac	ctt	gtg	tac	gca	gca	atc	1056
Tyr	Asn	Met	Pro	Phe	Glu	Val	Thr	Pro	Asp	Leu	Val	Tyr	Ala	Ala	Ile	
			340					345					350			
gTt	acc	gct	gat	tcc	gtc	ggg	cgg	tat	tat	aag	gaa	aaa	tgg	gca	tga	1104
Val	Thr	Ala	Asp	Ser	Val	Gly	Arg	Tyr	Tyr	Lys	Glu	Lys	Trp	Ala		
		355					360					365				

&lt;210&gt; SEQ ID NO 81

&lt;211&gt; LENGTH: 367

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Bacillus coagulans

-continued

&lt;400&gt; SEQUENCE: 81

Met Thr Lys Ile Ile Thr Ser Pro Ser Lys Phe Ile Gln Gly Pro Asp  
 1 5 10 15  
 Glu Leu Ser Arg Leu Ser Ala Tyr Thr Glu Arg Leu Gly Lys Lys Ala  
 20 25 30  
 Phe Ile Ile Ala Asp Asp Phe Val Thr Gly Leu Val Gly Lys Thr Val  
 35 40 45  
 Glu Glu Ser Tyr Ala Gly Lys Glu Thr Gly Tyr Gln Met Ala Leu Phe  
 50 55 60  
 Gly Gly Glu Cys Ser Lys Pro Glu Ile Glu Arg Leu Cys Glu Met Ser  
 65 70 75 80  
 Lys Ser Glu Glu Ala Asp Val Val Val Gly Ile Gly Gly Gly Lys Thr  
 85 90 95  
 Leu Asp Thr Ala Lys Ala Val Gly Tyr Tyr Asn Asn Ile Pro Val Ile  
 100 105 110  
 Val Ala Pro Thr Ile Ala Ser Thr Asp Ala Pro Thr Ser Ala Leu Ser  
 115 120 125  
 Val Ile Tyr Lys Glu Asn Gly Glu Phe Glu Glu Tyr Leu Met Leu Pro  
 130 135 140  
 Leu Asn Pro Thr Phe Val Ile Met Asp Thr Lys Val Ile Ala Ser Ala  
 145 150 155 160  
 Pro Ala Arg Leu Leu Val Ser Gly Met Gly Asp Ala Leu Ala Thr Tyr  
 165 170 175  
 Phe Glu Ala Arg Ala Thr Lys Arg Ala Asn Lys Thr Thr Met Ala Gly  
 180 185 190  
 Gly Arg Val Thr Glu Ala Ala Ile Ala Leu Ala Lys Leu Cys Tyr Asp  
 195 200 205  
 Thr Gln Ile Ser Glu Gly Leu Lys Ala Lys Leu Ala Ala Glu Lys His  
 210 215 220  
 Leu Val Thr Glu Ala Val Glu Lys Ile Ile Glu Ala Asn Thr Tyr Leu  
 225 230 235 240  
 Ser Gly Ile Gly Phe Glu Ser Gly Gly Leu Ala Ala Ala His Ala Ile  
 245 250 255  
 His Asn Gly Leu Thr Val Leu Glu Glu Thr His His Met Tyr His Gly  
 260 265 270  
 Glu Lys Val Ala Phe Gly Thr Leu Ala Gln Leu Ile Leu Glu Asp Ala  
 275 280 285  
 Pro Lys Ala Glu Ile Glu Glu Val Val Ser Phe Cys Leu Ser Val Gly  
 290 295 300  
 Leu Pro Val Thr Leu Gly Asp Leu Gly Val Lys Glu Leu Asn Glu Glu  
 305 310 315 320  
 Lys Leu Arg Lys Val Ala Glu Leu Ser Cys Ala Glu Gly Glu Thr Ile  
 325 330 335  
 Tyr Asn Met Pro Phe Glu Val Thr Pro Asp Leu Val Tyr Ala Ala Ile  
 340 345 350  
 Val Thr Ala Asp Ser Val Gly Arg Tyr Tyr Lys Glu Lys Trp Ala  
 355 360 365

&lt;210&gt; SEQ ID NO 82

&lt;211&gt; LENGTH: 999

&lt;212&gt; TYPE: DNA

&lt;213&gt; ORGANISM: Escherichia coli

&lt;220&gt; FEATURE:

&lt;221&gt; NAME/KEY: CDS

&lt;222&gt; LOCATION: (1)..(999)



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&lt;400&gt; SEQUENCE: 82

atg aaa acg tta ggt gaa ttt att gtc gaa aag cag cac gag ttt tct	48
Met Lys Thr Leu Gly Glu Phe Ile Val Glu Lys Gln His Glu Phe Ser	
1 5 10 15	
cat gct acc ggt gag ctc act gct ttg ctg tgc gca ata aaa ctg ggc	96
His Ala Thr Gly Glu Leu Thr Ala Leu Leu Ser Ala Ile Lys Leu Gly	
20 25 30	
gcc aag att atc cat cgc gat atc aac aaa gca gga ctg gtt gat atc	144
Ala Lys Ile Ile His Arg Asp Ile Asn Lys Ala Gly Leu Val Asp Ile	
35 40 45	
ctg ggt gcc agc ggt gct gag aac gtg cag ggc gag gtt cag cag aaa	192
Leu Gly Ala Ser Gly Ala Glu Asn Val Gln Gly Glu Val Gln Gln Lys	
50 55 60	
ctc gac ttg ttc gct aat gaa aaa ctg aaa gcc gca ctg aaa gca cgc	240
Leu Asp Leu Phe Ala Asn Glu Lys Leu Lys Ala Ala Leu Lys Ala Arg	
65 70 75 80	
gat atc gtt gcg ggc att gcc tct gaa gaa gaa gat gag att gtc gtc	288
Asp Ile Val Ala Gly Ile Ala Ser Glu Glu Glu Asp Glu Ile Val Val	
85 90 95	
ttt gaa ggc tgt gaa cac gca aaa tac gtg gtg ctg atg gac ccc ctg	336
Phe Glu Gly Cys Glu His Ala Lys Tyr Val Val Leu Met Asp Pro Leu	
100 105 110	
gat ggc tgc tcc aac atc gat gtt aac gtc tct gtc ggt acc att ttc	384
Asp Gly Ser Ser Asn Ile Asp Val Asn Val Ser Val Gly Thr Ile Phe	
115 120 125	
tcc atc tac cgc cgc gtt acg cct gtt ggc acg ccg gta acg gaa gaa	432
Ser Ile Tyr Arg Arg Val Thr Pro Val Gly Thr Pro Val Thr Glu Glu	
130 135 140	
gat ttc ctc cag cct ggt aac aaa cag gtt gcg gca ggt tac gtg gta	480
Asp Phe Leu Gln Pro Gly Asn Lys Gln Val Ala Ala Gly Tyr Val Val	
145 150 155 160	
tac ggc tcc tct acc atg ctg gtt tac acc acc gga tgc ggt gtt cac	528
Tyr Gly Ser Ser Thr Met Leu Val Tyr Thr Thr Gly Cys Gly Val His	
165 170 175	
gcc ttt act tac gat cct tgc ctc ggc gtt ttc tgc ctg tgc cag gaa	576
Ala Phe Thr Tyr Asp Pro Ser Leu Gly Val Phe Cys Leu Cys Gln Glu	
180 185 190	
cgg atg cgc ttc ccg gag aaa ggc aaa acc tac tcc atc aac gaa gga	624
Arg Met Arg Phe Pro Glu Lys Gly Lys Thr Tyr Ser Ile Asn Glu Gly	
195 200 205	
aac tac att aag ttt ccg aac ggg gtg aag aag tac att aaa ttc tgc	672
Asn Tyr Ile Lys Phe Pro Asn Gly Val Lys Lys Tyr Ile Lys Phe Cys	
210 215 220	
cag gaa gaa gat aaa tcc acc aac cgc cct tat acc tca cgt tat atc	720
Gln Glu Glu Asp Lys Ser Thr Asn Arg Pro Tyr Thr Ser Arg Tyr Ile	
225 230 235 240	
ggt tca ctg gtc gcg gat ttc cac cgt aac ctg ctg aaa ggc ggt att	768
Gly Ser Leu Val Ala Asp Phe His Arg Asn Leu Leu Lys Gly Gly Ile	
245 250 255	
tat ctc tac cca agc acc gcc agc cac ccg gac ggc aaa ctg cgt ttg	816
Tyr Leu Tyr Pro Ser Thr Ala Ser His Pro Asp Gly Lys Leu Arg Leu	
260 265 270	
ctg tat gag tgc aac ccg atg gca ttc ctg gcg gaa caa gcg ggc ggt	864
Leu Tyr Glu Cys Asn Pro Met Ala Phe Leu Ala Glu Gln Ala Gly Gly	
275 280 285	
aaa gcg agc gat ggc aaa gag cgt att ctg gat atc atc ccg gaa acc	912
Lys Ala Ser Asp Gly Lys Glu Arg Ile Leu Asp Ile Ile Pro Glu Thr	
290 295 300	
ctg cac cag cgc cgt tca ttc ttt gtc ggc aac gac cat atg gtt gaa	960

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Leu His Gln Arg Arg Ser Phe Phe Val Gly Asn Asp His Met Val Glu  
305 310 315 320

gat gtc gaa cgc ttt atc cgt gag ttc ccg gac gcg taa 999  
Asp Val Glu Arg Phe Ile Arg Glu Phe Pro Asp Ala  
325 330

<210> SEQ ID NO 83  
<211> LENGTH: 332  
<212> TYPE: PRT  
<213> ORGANISM: Escherichia coli

<400> SEQUENCE: 83

Met Lys Thr Leu Gly Glu Phe Ile Val Glu Lys Gln His Glu Phe Ser  
1 5 10 15

His Ala Thr Gly Glu Leu Thr Ala Leu Leu Ser Ala Ile Lys Leu Gly  
20 25 30

Ala Lys Ile Ile His Arg Asp Ile Asn Lys Ala Gly Leu Val Asp Ile  
35 40 45

Leu Gly Ala Ser Gly Ala Glu Asn Val Gln Gly Glu Val Gln Gln Lys  
50 55 60

Leu Asp Leu Phe Ala Asn Glu Lys Leu Lys Ala Ala Leu Lys Ala Arg  
65 70 75 80

Asp Ile Val Ala Gly Ile Ala Ser Glu Glu Glu Asp Glu Ile Val Val  
85 90 95

Phe Glu Gly Cys Glu His Ala Lys Tyr Val Val Leu Met Asp Pro Leu  
100 105 110

Asp Gly Ser Ser Asn Ile Asp Val Asn Val Ser Val Gly Thr Ile Phe  
115 120 125

Ser Ile Tyr Arg Arg Val Thr Pro Val Gly Thr Pro Val Thr Glu Glu  
130 135 140

Asp Phe Leu Gln Pro Gly Asn Lys Gln Val Ala Ala Gly Tyr Val Val  
145 150 155 160

Tyr Gly Ser Ser Thr Met Leu Val Tyr Thr Thr Gly Cys Gly Val His  
165 170 175

Ala Phe Thr Tyr Asp Pro Ser Leu Gly Val Phe Cys Leu Cys Gln Glu  
180 185 190

Arg Met Arg Phe Pro Glu Lys Gly Lys Thr Tyr Ser Ile Asn Glu Gly  
195 200 205

Asn Tyr Ile Lys Phe Pro Asn Gly Val Lys Lys Tyr Ile Lys Phe Cys  
210 215 220

Gln Glu Glu Asp Lys Ser Thr Asn Arg Pro Tyr Thr Ser Arg Tyr Ile  
225 230 235 240

Gly Ser Leu Val Ala Asp Phe His Arg Asn Leu Leu Lys Gly Gly Ile  
245 250 255

Tyr Leu Tyr Pro Ser Thr Ala Ser His Pro Asp Gly Lys Leu Arg Leu  
260 265 270

Leu Tyr Glu Cys Asn Pro Met Ala Phe Leu Ala Glu Gln Ala Gly Gly  
275 280 285

Lys Ala Ser Asp Gly Lys Glu Arg Ile Leu Asp Ile Ile Pro Glu Thr  
290 295 300

Leu His Gln Arg Arg Ser Phe Phe Val Gly Asn Asp His Met Val Glu  
305 310 315 320

Asp Val Glu Arg Phe Ile Arg Glu Phe Pro Asp Ala  
325 330

<210> SEQ ID NO 84





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<210> SEQ ID NO 85  
 <211> LENGTH: 272  
 <212> TYPE: PRT  
 <213> ORGANISM: Escherichia coli

<400> SEQUENCE: 85

Met Thr Thr Arg Val Ile Ala Leu Asp Leu Asp Gly Thr Leu Leu Thr  
 1 5 10 15  
 Pro Lys Lys Thr Leu Leu Pro Ser Ser Ile Glu Ala Leu Ala Arg Ala  
 20 25 30  
 Arg Glu Ala Gly Tyr Gln Leu Ile Ile Val Thr Gly Arg His His Val  
 35 40 45  
 Ala Ile His Pro Phe Tyr Gln Ala Leu Ala Leu Asp Thr Pro Ala Ile  
 50 55 60  
 Cys Cys Asn Gly Thr Tyr Leu Tyr Asp Tyr His Ala Lys Thr Val Leu  
 65 70 75 80  
 Glu Ala Asp Pro Met Pro Val Ile Lys Ala Leu Gln Leu Ile Glu Met  
 85 90 95  
 Leu Asn Glu His His Ile His Gly Leu Met Tyr Val Asp Asp Ala Met  
 100 105 110  
 Val Tyr Glu His Pro Thr Gly His Val Ile Arg Thr Ser Asn Trp Ala  
 115 120 125  
 Gln Thr Leu Pro Pro Glu Gln Arg Pro Thr Phe Thr Gln Val Ala Ser  
 130 135 140  
 Leu Ala Glu Thr Ala Gln Gln Val Asn Ala Val Trp Lys Phe Ala Leu  
 145 150 155 160  
 Thr His Asp Asp Leu Pro Gln Leu Gln His Phe Gly Lys His Val Glu  
 165 170 175  
 His Glu Leu Gly Leu Glu Cys Glu Trp Ser Trp His Asp Gln Val Asp  
 180 185 190  
 Ile Ala Arg Gly Gly Asn Ser Lys Gly Lys Arg Leu Thr Lys Trp Val  
 195 200 205  
 Glu Ala Gln Gly Trp Ser Met Glu Asn Val Val Ala Phe Gly Asp Asn  
 210 215 220  
 Phe Asn Asp Ile Ser Met Leu Glu Ala Ala Gly Thr Gly Val Ala Met  
 225 230 235 240  
 Gly Asn Ala Asp Asp Ala Val Lys Ala Arg Ala Asn Ile Val Ile Gly  
 245 250 255  
 Asp Asn Thr Thr Asp Ser Ile Ala Gln Phe Ile Tyr Ser His Leu Ile  
 260 265 270

<210> SEQ ID NO 86  
 <211> LENGTH: 1728  
 <212> TYPE: DNA  
 <213> ORGANISM: Escherichia coli  
 <220> FEATURE:  
 <221> NAME/KEY: CDS  
 <222> LOCATION: (1)..(1728)

<400> SEQUENCE: 86

atg att tca ggc att tta gca tcc ccg ggt atc gct ttc ggt aaa gct 48  
 Met Ile Ser Gly Ile Leu Ala Ser Pro Gly Ile Ala Phe Gly Lys Ala  
 1 5 10 15  
 ctg ctt ctg aaa gaa gac gaa att gtc att gac cgg aaa aaa att tct 96  
 Leu Leu Leu Lys Glu Asp Glu Ile Val Ile Asp Arg Lys Lys Ile Ser  
 20 25 30  
 gcc gac cag gtt gat cag gaa gtt gaa cgt ttt ctg agc ggt cgt gcc 144  
 Ala Asp Gln Val Asp Gln Glu Val Glu Arg Phe Leu Ser Gly Arg Ala  
 35 40 45

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aag gca tca gcc cag ctg gaa acg atc aaa acg aaa gct ggt gaa acg	192
Lys Ala Ser Ala Gln Leu Glu Thr Ile Lys Thr Lys Ala Gly Glu Thr	
50 55 60	
ttc ggt gaa gaa aaa gaa gcc atc ttt gaa ggg cat att atg ctg ctc	240
Phe Gly Glu Glu Lys Glu Ala Ile Phe Glu Gly His Ile Met Leu Leu	
65 70 75 80	
gaa gat gag gag ctg gag cag gaa atc ata gcc ctg att aaa gat aag	288
Glu Asp Glu Glu Leu Glu Gln Glu Ile Ile Ala Leu Ile Lys Asp Lys	
85 90 95	
cac atg aca gct gac gca gct gct cat gaa gtt atc gaa ggt cag gct	336
His Met Thr Ala Asp Ala Ala Ala His Glu Val Ile Glu Gly Gln Ala	
100 105 110	
tct gcc ctg gaa gag ctg gat gat gaa tac ctg aaa gaa cgt gcg gct	384
Ser Ala Leu Glu Glu Leu Asp Asp Glu Tyr Leu Lys Glu Arg Ala Ala	
115 120 125	
gac gta cgt gat atc ggt aag cgc ctg ctg cgc aac atc ctg ggc ctg	432
Asp Val Arg Asp Ile Gly Lys Arg Leu Leu Arg Asn Ile Leu Gly Leu	
130 135 140	
aag att atc gac ctg agc gcc att cag gat gaa gtc att ctg gtt gcc	480
Lys Ile Ile Asp Leu Ser Ala Ile Gln Asp Glu Val Ile Leu Val Ala	
145 150 155 160	
gct gac ctg acg ccg tcc gaa acc gca cag ctg aac ctg aag aag gtg	528
Ala Asp Leu Thr Pro Ser Glu Thr Ala Gln Leu Asn Leu Lys Lys Val	
165 170 175	
ctg ggt ttc atc acc gac gcg ggt ggc cgt act tcc cac acc tct atc	576
Leu Gly Phe Ile Thr Asp Ala Gly Arg Thr Ser His Thr Ser Ile	
180 185 190	
atg gcg cgt tct ctg gaa cta cct gct atc gtg ggt acc ggt agc gtc	624
Met Ala Arg Ser Leu Glu Leu Pro Ala Ile Val Gly Thr Gly Ser Val	
195 200 205	
acc tct cag gtg aaa aat gac gac tat ctg att ctg gat gcc gta aat	672
Thr Ser Gln Val Lys Asn Asp Asp Tyr Leu Ile Leu Asp Ala Val Asn	
210 215 220	
aat cag gtt tac gtc aat cca acc aac gaa gtt att gat aaa atg cgc	720
Asn Gln Val Tyr Val Asn Pro Thr Asn Glu Val Ile Asp Lys Met Arg	
225 230 235 240	
gct gtt cag gag caa gtg gct tct gaa aaa gca gag ctt gct aaa ctg	768
Ala Val Gln Glu Gln Val Ala Ser Glu Lys Ala Glu Leu Ala Lys Leu	
245 250 255	
aaa gat ctg cca gct att acg ctg gac ggt cac cag gta gaa gta tgc	816
Lys Asp Leu Pro Ala Ile Thr Leu Asp Gly His Gln Val Glu Val Cys	
260 265 270	
gct aac att ggt acg gtt cgt gac gtt gaa ggt gca gag cgt aac ggc	864
Ala Asn Ile Gly Thr Val Arg Asp Val Glu Gly Ala Glu Arg Asn Gly	
275 280 285	
gct gaa ggc gtt ggt ctg tat cgt act gag ttc ctg ttc atg gac cgc	912
Ala Glu Gly Val Gly Leu Tyr Arg Thr Glu Phe Leu Phe Met Asp Arg	
290 295 300	
gac gca ctg ccc act gaa gaa gaa cag ttt gct gct tac aaa gca gtg	960
Asp Ala Leu Pro Thr Glu Glu Glu Gln Phe Ala Ala Tyr Lys Ala Val	
305 310 315 320	
gct gaa gcg tgt ggc tcg caa gcg gtt atc gtt cgt acc atg gac atc	1008
Ala Glu Ala Cys Gly Ser Gln Ala Val Ile Val Arg Thr Met Asp Ile	
325 330 335	
ggc ggc gac aaa gag ctg cca tac atg aac ttc ccg aaa gaa gag aac	1056
Gly Gly Asp Lys Glu Leu Pro Tyr Met Asn Phe Pro Lys Glu Glu Asn	
340 345 350	
ccg ttc ctc ggc tgg cgc gct atc cgt atc gcg atg gat cgt aga gag	1104
Pro Phe Leu Gly Trp Arg Ala Ile Arg Ile Ala Met Asp Arg Arg Glu	
355 360 365	

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atc ctg cgc gat cag ctc cgc gct atc ctg cgt gcc teg gct ttc ggt	1152
Ile Leu Arg Asp Gln Leu Arg Ala Ile Leu Arg Ala Ser Ala Phe Gly	
370 375 380	
aaa ttg cgc att atg ttc ccg atg atc atc tct gtt gaa gaa gtg cgt	1200
Lys Leu Arg Ile Met Phe Pro Met Ile Ile Ser Val Glu Glu Val Arg	
385 390 395 400	
gca ctg cgc aaa gag atc gaa atc tac aaa cag gaa ctg cgc gac gaa	1248
Ala Leu Arg Lys Glu Ile Glu Ile Tyr Lys Gln Glu Leu Arg Asp Glu	
405 410 415	
ggt aaa gcg ttt gac gag tca att gaa atc ggc gta atg gtg gaa aca	1296
Gly Lys Ala Phe Asp Glu Ser Ile Glu Ile Gly Val Met Val Glu Thr	
420 425 430	
ccg gct gcc gca aca att gca cgt cat tta gcc aaa gaa gtt gat ttc	1344
Pro Ala Ala Ala Thr Ile Ala Arg His Leu Ala Lys Glu Val Asp Phe	
435 440 445	
ttt agt atc ggc acc aat gat tta acg cag tac act ctg gca gtt gac	1392
Phe Ser Ile Gly Thr Asn Asp Leu Thr Gln Tyr Thr Leu Ala Val Asp	
450 455 460	
cgt ggt aat gat atg att tca cac ctt tac cag cca atg tca ccg tcc	1440
Arg Gly Asn Asp Met Ile Ser His Leu Tyr Gln Pro Met Ser Pro Ser	
465 470 475 480	
gtg ctg aac ttg atc aag caa gtt att gat gct tct cat gct gaa ggc	1488
Val Leu Asn Leu Ile Lys Gln Val Ile Asp Ala Ser His Ala Glu Gly	
485 490 495	
aaa tgg act ggc atg tgt ggt gag ctt gct ggc gat gaa cgt gct aca	1536
Lys Trp Thr Gly Met Cys Gly Glu Leu Ala Gly Asp Glu Arg Ala Thr	
500 505 510	
ctt ctg ttg ctg ggg atg ggt ctg gac gaa ttc tct atg agc gcc att	1584
Leu Leu Leu Leu Gly Met Gly Leu Asp Glu Phe Ser Met Ser Ala Ile	
515 520 525	
tct atc ccg cgc att aag aag att atc cgt aac acg aac ttc gaa gat	1632
Ser Ile Pro Arg Ile Lys Lys Ile Ile Arg Asn Thr Asn Phe Glu Asp	
530 535 540	
gcg aag gtg tta gca gag cag gct ctt gct caa ccg aca acg gac gag	1680
Ala Lys Val Leu Ala Glu Gln Ala Leu Ala Gln Pro Thr Thr Asp Glu	
545 550 555 560	
tta atg acg ctg gtt aac aag ttc att gaa gaa aaa aca atc tgc taa	1728
Leu Met Thr Leu Val Asn Lys Phe Ile Glu Glu Lys Thr Ile Cys	
565 570 575	

&lt;210&gt; SEQ ID NO 87

&lt;211&gt; LENGTH: 575

&lt;212&gt; TYPE: PRT

&lt;213&gt; ORGANISM: Escherichia coli

&lt;400&gt; SEQUENCE: 87

Met Ile Ser Gly Ile Leu Ala Ser Pro Gly Ile Ala Phe Gly Lys Ala	1	5	10	15
Leu Leu Leu Lys Glu Asp Glu Ile Val Ile Asp Arg Lys Lys Ile Ser	20	25	30	
Ala Asp Gln Val Asp Gln Glu Val Glu Arg Phe Leu Ser Gly Arg Ala	35	40	45	
Lys Ala Ser Ala Gln Leu Glu Thr Ile Lys Thr Lys Ala Gly Glu Thr	50	55	60	
Phe Gly Glu Glu Lys Glu Ala Ile Phe Glu Gly His Ile Met Leu Leu	65	70	75	80
Glu Asp Glu Glu Leu Glu Gln Glu Ile Ile Ala Leu Ile Lys Asp Lys	85	90	95	
His Met Thr Ala Asp Ala Ala Ala His Glu Val Ile Glu Gly Gln Ala				



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100					105					110					
Ser	Ala	Leu	Glu	Glu	Leu	Asp	Asp	Glu	Tyr	Leu	Lys	Glu	Arg	Ala	Ala
	115						120					125			
Asp	Val	Arg	Asp	Ile	Gly	Lys	Arg	Leu	Leu	Arg	Asn	Ile	Leu	Gly	Leu
	130					135					140				
Lys	Ile	Ile	Asp	Leu	Ser	Ala	Ile	Gln	Asp	Glu	Val	Ile	Leu	Val	Ala
	145				150					155					160
Ala	Asp	Leu	Thr	Pro	Ser	Glu	Thr	Ala	Gln	Leu	Asn	Leu	Lys	Lys	Val
				165					170					175	
Leu	Gly	Phe	Ile	Thr	Asp	Ala	Gly	Gly	Arg	Thr	Ser	His	Thr	Ser	Ile
			180					185					190		
Met	Ala	Arg	Ser	Leu	Glu	Leu	Pro	Ala	Ile	Val	Gly	Thr	Gly	Ser	Val
		195					200					205			
Thr	Ser	Gln	Val	Lys	Asn	Asp	Asp	Tyr	Leu	Ile	Leu	Asp	Ala	Val	Asn
	210					215						220			
Asn	Gln	Val	Tyr	Val	Asn	Pro	Thr	Asn	Glu	Val	Ile	Asp	Lys	Met	Arg
	225					230				235					240
Ala	Val	Gln	Glu	Gln	Val	Ala	Ser	Glu	Lys	Ala	Glu	Leu	Ala	Lys	Leu
				245					250					255	
Lys	Asp	Leu	Pro	Ala	Ile	Thr	Leu	Asp	Gly	His	Gln	Val	Glu	Val	Cys
			260					265					270		
Ala	Asn	Ile	Gly	Thr	Val	Arg	Asp	Val	Glu	Gly	Ala	Glu	Arg	Asn	Gly
		275					280					285			
Ala	Glu	Gly	Val	Gly	Leu	Tyr	Arg	Thr	Glu	Phe	Leu	Phe	Met	Asp	Arg
	290					295					300				
Asp	Ala	Leu	Pro	Thr	Glu	Glu	Glu	Gln	Phe	Ala	Ala	Tyr	Lys	Ala	Val
	305					310				315					320
Ala	Glu	Ala	Cys	Gly	Ser	Gln	Ala	Val	Ile	Val	Arg	Thr	Met	Asp	Ile
				325					330					335	
Gly	Gly	Asp	Lys	Glu	Leu	Pro	Tyr	Met	Asn	Phe	Pro	Lys	Glu	Glu	Asn
			340					345					350		
Pro	Phe	Leu	Gly	Trp	Arg	Ala	Ile	Arg	Ile	Ala	Met	Asp	Arg	Arg	Glu
		355				360						365			
Ile	Leu	Arg	Asp	Gln	Leu	Arg	Ala	Ile	Leu	Arg	Ala	Ser	Ala	Phe	Gly
	370					375					380				
Lys	Leu	Arg	Ile	Met	Phe	Pro	Met	Ile	Ile	Ser	Val	Glu	Glu	Val	Arg
	385				390					395					400
Ala	Leu	Arg	Lys	Glu	Ile	Glu	Ile	Tyr	Lys	Gln	Glu	Leu	Arg	Asp	Glu
				405					410					415	
Gly	Lys	Ala	Phe	Asp	Glu	Ser	Ile	Glu	Ile	Gly	Val	Met	Val	Glu	Thr
			420					425					430		
Pro	Ala	Ala	Ala	Thr	Ile	Ala	Arg	His	Leu	Ala	Lys	Glu	Val	Asp	Phe
		435					440					445			
Phe	Ser	Ile	Gly	Thr	Asn	Asp	Leu	Thr	Gln	Tyr	Thr	Leu	Ala	Val	Asp
	450					455					460				
Arg	Gly	Asn	Asp	Met	Ile	Ser	His	Leu	Tyr	Gln	Pro	Met	Ser	Pro	Ser
	465				470					475					480
Val	Leu	Asn	Leu	Ile	Lys	Gln	Val	Ile	Asp	Ala	Ser	His	Ala	Glu	Gly
				485					490					495	
Lys	Trp	Thr	Gly	Met	Cys	Gly	Glu	Leu	Ala	Gly	Asp	Glu	Arg	Ala	Thr
			500					505					510		
Leu	Leu	Leu	Leu	Gly	Met	Gly	Leu	Asp	Glu	Phe	Ser	Met	Ser	Ala	Ile
		515					520					525			

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Ser Ile Pro Arg Ile Lys Lys Ile Ile Arg Asn Thr Asn Phe Glu Asp  
530 535 540

Ala Lys Val Leu Ala Glu Gln Ala Leu Ala Gln Pro Thr Thr Asp Glu  
545 550 555 560

Leu Met Thr Leu Val Asn Lys Phe Ile Glu Glu Lys Thr Ile Cys  
565 570 575

<210> SEQ ID NO 88

<211> LENGTH: 1740

<212> TYPE: DNA

<213> ORGANISM: Artificial sequence

<220> FEATURE:

<223> OTHER INFORMATION: attR-cat-attL-PtacM2-SD-spacer

<400> SEQUENCE: 88

tctagacgct caagttagta taaaaaagct gaacgagaaa cgtaaaatga tataaatatc 60  
aatatattaa attagatddd gcataaaaaa cagactacat aatactgtaa aacacaacat 120  
atgcagtcac tatgaatcaa ctacttagat ggtattagtg acctgtaaca gactgcagtg 180  
gtcgaaaaaa aaagcccgca ctgtcaggtg cgggcttttt tctgtgttaa gcttcgacga 240  
attdctgcca ttcacccgct tattatcaact tattcaggcg tagcaccagg cgtttaaggg 300  
caccaataac tgccttaaaa aaattacgcc ccgccttccc actcatcgca gtactgttgt 360  
aattcattaa gcattctgcc gacatggaag ccatcacaga cggcatgatg aacctgaatc 420  
gccagcggca tcagcacctt gtgccttgc gtataatatt tgcccatggt gaaaacgggg 480  
gcgaagaagt tgtccatatt ggccacgttt aaatcaaac tggtgaaact caccagggga 540  
ttggctgaga cgaaaaacat attctcaata aacccttag ggaaataggc caggttttca 600  
ccgtaacacg ccacatcttg cgaatatatg tgtagaaact gccggaaatc gtcgtggtat 660  
tactccaga gcgatgaaaa cgtttcagtt tgetcatgga aaacgggtga acaaggggta 720  
acactatccc atatcaccag ctcaccgtct ttcattgcca tacggaattc cggatgagca 780  
ttcatcaggc gggcaagaat gtgaataaag gccggataaa acttgtgctt atttttcttt 840  
acggtcttta aaaaggccgt aatatccagc tgaacggtct gggtataggt acattgagca 900  
actgactgaa atgcctcaaa atgttcttta cgatgccatt gggatatatc aacgggtgga 960  
tatccagtga tttttttctc ctttttagct tccttagctc ctgaaaatct cggatccggc 1020  
caagctagct tggctctagc tagagcgcgc ggttgacgct gctagtgtta cctagcgatt 1080  
tgtatcttac tgcattgttac ttcattgtgt caatacctgt ttttcgtgcg acttatcagg 1140  
ctgtctactt atccggagat ccacaggacg ggtgtggtcg ccatgatcgc gtagtcgata 1200  
gtggctccaa gtagcgaagc gagcaggact gggcggcggc caaagcggtc ggacagtgct 1260  
ccgagaacgg gtgcgcatag aaattgcatc aacgcatata gcgctagcag cacgccatag 1320  
tgactggcga tgctgtcgga atggacgata tcccgaaga ggcccggcag taccggcata 1380  
accaagccta tgcctacagc atccagggtg acggtgccga ggatgacgat gagcgcattg 1440  
ttagatttca tacacgggtc ctgactgctg tagcaattta actgtgataa actaccgcat 1500  
taaagcttat cgatgataag ctgtcaaaca tgagaattcg aaatcaata atgattttat 1560  
tttgactgat agtgacctgt tcggtgcaac aaattgataa gcaatgcttt tttataatgc 1620  
caacttagta taaaaaagca ggcttcaaga tctctcccca tccccctgtg tacaattaat 1680  
catcggctcg tataatgtgt ggaattgtga gcggataaca atttcacaca ggagactgcc 1740

<210> SEQ ID NO 89

<211> LENGTH: 1740

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<212> TYPE: DNA
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: attR-cat-attL-PtacM3-SD-spacer

<400> SEQUENCE: 89
tctagacgct caagttagta taaaaaagct gaacgagaaa cgtaaaatga tataaatatc      60
aatatattaa attagatttt gcataaaaaa cagactacat aatactgtaa aacacaacat      120
atgcagtcac tatgaatcaa ctacttagat ggtattagtg acctgtaaca gactgcagtg      180
gtcgaaaaaa aaagcccgca ctgtcagggtg cgggcttttt tctgtgtaa gcttcgacga      240
atctctgcca ttcacccgct tattatcact tattcaggcg tagcaccagg cgtttaaggg      300
caccaataac tgccttaaaa aaattacgcc ccgccctgcc actcatcgca gtactggtgt      360
aattcattaa gcattctgcc gacatggaag ccatcacaga cggcatgatg aacctgaatc      420
gccagcggca tcagcacctt gtcgccttgc gtataatatt tgcccatggt gaaaacgggg      480
gcgaagaagt tgtccatatt ggccacgttt aaatcaaac tggtgaaact caccagggga      540
ttggctgaga cgaaaaacat attctcaata aacccttagg ggaaataggc caggttttca      600
ccgtaacacg ccacatcttg cgaatatatg ttagaaaact gccggaaatc gtcgtggtat      660
tactccaga gcatgaaaaa cgtttcagtt tgctcatgga aaacgggtga acaaggggtga      720
acactatccc ataccaccag ctcaccgtct ttcattgcca tacggaattc cggatgagca      780
ttcatcaggc gggcaagaat gtgaataaag gccggataaa acttgtgctt atttttcttt      840
acggctctta aaaaggccgt aatatccagc tgaacggctc ggttataggt acattgagca      900
actgactgaa atgcctcaaa atgttcttta cgatgccatt gggatatatc aacggtggtg      960
tatccagtga tttttttctc catttttagct tccttagctc ctgaaaatct cggatccggc     1020
caagctagct tggctctagc tagagcgcgc ggttgacgct gctagtgtta cctagcagatt     1080
tgtatcttac tgcattgtac ttcattgttg caatacctgt ttttcgtgcg acttatcagg     1140
ctgtctactt atccggagat ccacaggacg ggtgtggctg ccatgatcgc gtagtcgata     1200
gtggctccaa gtagcgaagc gagcaggact gggcggcggc caaagcggtc ggacagtgct     1260
ccgagaacgg gtgcgcatag aaattgcatc aacgcatata gcgctagcag cacgccatag     1320
tgactggcga tgctgtcga atggacgata tcccgaaga ggcccggcag taccggcata     1380
accaagccta tgcctacagc atccaggggtg acggtgccga ggatgacgat gagcgcattg     1440
ttagatttca tacacgggtg ctgactgctg tagcaattta actgtgataa actaccgcat     1500
taaagcttat cgatgataag ctgtcaaca tgagaattcg aaatcaata atgattttat     1560
tttgactgat agtgacctgt tcggtgcaac aaattgataa gcaatgcttt tttataatgc     1620
caacttagta taaaaaagca ggcttcaaga tctctcccca tcccctgtt ggcaattaat     1680
catcggtcgt tataatgtgt ggaattgtga gcggataaca atttcacaca ggagactgcc     1740

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<210> SEQ ID NO 90
<211> LENGTH: 2847
<212> TYPE: DNA
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: PtacM2gldA::Cm

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<400> SEQUENCE: 90
tctagacgct caagttagta taaaaaagct gaacgagaaa cgtaaaatga tataaatatc      60
aatatattaa attagatttt gcataaaaaa cagactacat aatactgtaa aacacaacat      120
atgcagtcac tatgaatcaa ctacttagat ggtattagtg acctgtaaca gactgcagtg      180

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gtcgaaaaaa	aaagcccgca	ctgtcagggtg	egggtttttt	tctgtgttaa	gcttcgacga	240
atctctgcca	ttcatccgct	tattatcact	tattcaggcg	tagcaccagg	cgtttaaggg	300
caccaataac	tgccttaaaa	aaattacgcc	ccgccctgcc	actcatcgca	gtactgttgt	360
aattcattaa	gcattctgcc	gacatggaag	ccatcacaga	cggcatgatg	aacctgaatc	420
gccagcggca	tcagcacctt	gtcgccttgc	gtataatatt	tgcccatggt	gaaaacgggg	480
gcgaagaagt	tgtccatatt	ggccacgttt	aatcaaaaac	tgggtgaaact	caccagggga	540
ttggctgaga	cgaaaaacat	attctcaata	aaccctttag	ggaaataggc	caggttttca	600
ccgtaacacg	ccacatcttg	cgaatatatg	tgtagaaaact	gccggaaatc	gtcgtggtat	660
tcactccaga	gcatgaaaa	cgtttcagtt	tgctcatgga	aaacggtgta	acaaggggta	720
acactatccc	ataccaccag	ctcacctctc	ttcattgcca	tacggaattc	cggatgagca	780
ttcatcaggc	gggcaagaat	gtgaataaag	gccggataaa	acttgtgctt	atctttcttt	840
acggctctta	aaaaggccgt	aatatccagc	tgaacggctc	ggttataggt	acattgagca	900
actgactgaa	atgcctcaaa	atgttcttta	cgatgccatt	gggatatac	aacggtggtg	960
tatccagtga	ttttttctc	catttttagct	tccttagctc	ctgaaaatct	cggatccggc	1020
caagctagct	tggtcttagc	tagagcggcc	ggttgacgct	gctagtgtta	cctagcgatt	1080
tgtatcttac	tgcatgttac	ttcatggtgt	caatacctgt	tttctgtgcg	acttatcagg	1140
ctgtctactt	atccggagat	ccacaggacg	ggtgtggtcg	ccatgatcgc	gtagtcgata	1200
gtggctccaa	gtagcgaagc	gagcaggact	ggcggcggc	caaagcggtc	ggacagtgct	1260
ccgagaacgg	gtgcgcatag	aaattgcatc	aacgcatata	gcgctagcag	cacgccatag	1320
tgactggcga	tgctgtcgga	atggacgata	tcccgaaga	ggcccggcag	taccggcata	1380
accaagccta	tgctacagc	atccaggggtg	acggtgccga	ggatgacgat	gagcgcattg	1440
ttagatttca	tacacgggtc	ctgactgcgt	tagcaattta	actgtgataa	actaccgcat	1500
taaagcttat	cgatgataag	ctgtcaaaca	tgagaattcg	aatcaataa	atgattttat	1560
tttgactgat	agtgacctgt	tcggtgcaac	aaattgataa	gcaatgcttt	tttataatgc	1620
caacttagta	taaaaaagca	ggcttcaaga	tcttctctcc	ccatccccct	gtgtacaatt	1680
aatcatcggc	tcgtataatg	tgtggaattg	tgagcggata	acaatttcac	acaggagact	1740
gccatggacc	gcattattca	atcaccgggt	aaatacatcc	agggcgctga	tgtgattaat	1800
cgtctggggc	aatacctgaa	gccgctggca	gaacgctggt	tagtggtggg	tgacaaattt	1860
gttttagggt	ttgctcaatc	cactgtcgag	aaaagcttta	aagatgctgg	actggtagta	1920
gaaattgcgc	cgtttggcgg	tgaatgttcg	caaaatgaga	tcgaccgtct	gcgtggcatc	1980
gcggagactg	cgcagtgtgg	cgcaattctc	ggtatcggtg	gcggaaaaac	cctcgatact	2040
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<210> SEQ ID NO 91
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<212> TYPE: DNA
<213> ORGANISM: Artificial sequence
<220> FEATURE:
<223> OTHER INFORMATION: PtacM3gldA::Cm

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<400> SEQUENCE: 91

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&lt;212&gt; TYPE: DNA

&lt;213&gt; ORGANISM: Artificial sequence

&lt;220&gt; FEATURE:

&lt;223&gt; OTHER INFORMATION: PtacM fsaB-gldA::Cm

&lt;400&gt; SEQUENCE: 92

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<212> TYPE: DNA
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<210> SEQ ID NO 94  
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What is claimed is:

**1.** A method for producing an L-amino acid, comprising:  
 (A) providing an *Escherichia coli* having an L-amino acid-producing ability and modified to increase glycerol dehydrogenase and dihydroxyacetone kinase activities,  
 (B) culturing said *Escherichia coli* in a medium containing glycerol as a carbon source to produce and accumulate an L-amino acid in the medium or cells, and  
 (C) collecting the L-amino acid from the medium or the cells,  
 wherein said *Escherichia coli* is modified to increase the glycerol dehydrogenase and dihydroxyacetone kinase activities by increasing copy numbers of a glycerol dehydrogenase gene and dihydroxyacetone kinase gene, and/or by replacing a promoter for the genes with a stronger promoter, and  
 wherein the dihydroxyacetone kinase uses ATP as a phosphate donor.

**2.** The method of claim **1**, wherein the copy numbers of the genes are increased by transformation of the *Escherichia coli* with a multi-copy vector containing the genes and/or by introduction of the genes into the chromosome of the *Escherichia coli*.

**3.** The method of claim **1**, wherein the *Escherichia coli* is further modified to increase glycerol uptake activity by increasing copy number of a gene encoding for a glycerol facilitator, and/or by replacing a promoter for the gene for a glycerol facilitator with a stronger promoter.

**4.** The method of claim **1**, wherein the *Escherichia coli* is further modified to increase at least one activity of an enzyme selected from the group consisting of triosephosphate isomerase, fructose biphosphate aldolase, fructose-1,6-bisphosphatase, fructose-6-phosphate aldolase, and combinations thereof,  
 wherein the at least one activity of the enzyme is increased by increasing the copy number of a gene coding for the enzyme, and/or by replacing a promoter for the gene with a stronger promoter.

**5.** The method of claim **1**, wherein the *Escherichia coli* is further modified to reduce at least one activity of glycerol kinase and/or membrane-binding type glycerol-3-phosphate dehydrogenase.

**6.** The method of claim **1**, wherein the L-amino acid is selected from the group consisting of L-glutamic acid, L-lysine, L-leucine, L-isoleucine, L-valine, L-tryptophan, L-phenylalanine, L-tyrosine, L-threonine, L-methionine, L-cysteine, L-arginine, L-serine, L-proline, L-aspartic acid, L-asparagine, L-glutamine, L-histidine, and combinations thereof.

**7.** The method of claim **4**, wherein the copy number of a gene coding for the enzyme is increased by transformation of the *Escherichia coli* with a multi-copy vector containing the gene and/or introduction of the gene into the chromosome of the *Escherichia coli*.

**8.** The method of claim **1**, wherein the glycerol dehydrogenase gene is obtained from *Escherichia coli*.

**9.** The method of claim **8**, wherein the glycerol dehydrogenase gene encodes a protein selected from the group consisting of:  
 (a) a protein comprising the amino acid sequence of SEQ ID NO: 2; and  
 (b) a protein comprising the amino acid sequence which is not less than 95% identical to the amino acid sequence of SEQ ID NO: 2 and the protein has glycerol dehydrogenase activity.

**10.** The method of claim **1**, wherein the promoter under which the glycerol dehydrogenase gene is placed is a promoter obtained from tac promoter.

**11.** The method of claim **1**, wherein the dihydroxyacetone kinase gene is obtained from *Saccharomyces cerevisiae*.

**12.** The method of claim **11**, wherein the dihydroxyacetone kinase gene encodes a protein selected from the group consisting of:  
 (c) a protein comprising the amino acid sequence of SEQ ID NO: 4; and  
 (d) a protein comprising the amino acid sequence which is not less than 95% identical to the amino acid sequence of SEQ ID NO: 4,  
 and the protein has dihydroxyacetone kinase activity.

**13.** The method of claim **1**, wherein the promoter under which dihydroxyacetone kinase gene is placed is a promoter obtained from tac promoter.

\* \* \* \* \*